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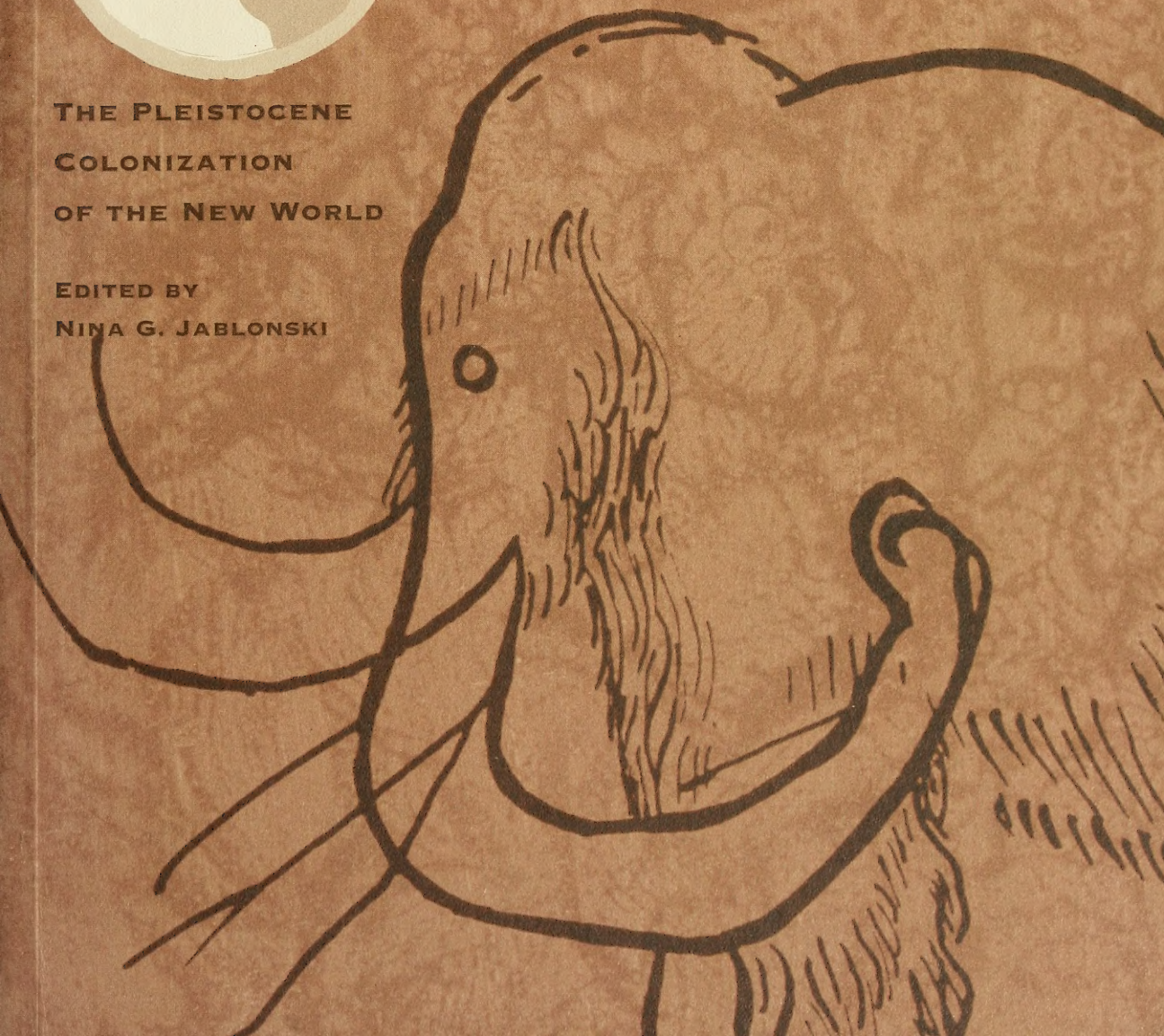
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The First Americans



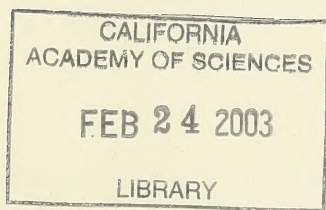
THE PLEISTOCENE
COLONIZATION
OF THE NEW WORLD

EDITED BY
NINA G. JABLONSKI



Wattis Symposium Series in Anthropology

**MEMOIRS OF THE CALIFORNIA ACADEMY
OF SCIENCES, NUMBER 27**





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OF THE NEW WORLD

VOLUME EDITOR

NINA G. JABLONSKI

Wattis Symposium Series in Anthropology

MEMOIRS OF THE CALIFORNIA ACADEMY OF SCIENCES

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The First Americans

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PREFACE



San Francisco is privileged to have as one of her citizens Mrs. Phyllis Wattis, a woman of tremendous warmth, sincerity and generosity. The support that she has given to the city's educational and cultural institutions in the last thirty years has been nothing short of phenomenal, and being on the receiving end of some of the largesse that she has bestowed on the California Academy of Sciences has been wonderful. The passionate and wide-ranging interest that Mrs. Wattis has maintained in anthropology over the years has inspired her to support several major programming initiatives at the Academy, including the Wattis Symposia in Anthropology, which were begun in 1993. These symposia were conceived as occasions for the presentation of new information (to the public) on a topic of broad interest and importance in anthropology. The scholars participating were to be the best in the world. After the great success of the first symposium, it was decided that the edited proceedings of that symposium and all subsequent ones should be published, so as to bring the spirit and content of each symposium to a much larger audience. I am happy to say that we have succeeded in this enterprise, with each symposium and its respective volume seeming to be better than the last. The Fourth Wattis Symposium, "The First Americans: The Pleistocene Colonization of the New World," was held on October 2, 1999 at the California Academy of Sciences, and was attended by a full house of over 350 people. We knew that the time was ripe for another airing of this long-debated topic. The symposium was a great success, as judged by the reactions of the participants and the audience, and the positive "chemistry" that was established at the symposium has, happily, extended into this volume. I am grateful, first and foremost to Mrs. Phyllis Wattis for making this symposium possible through her generous donations to the Department of Anthropology of the California Academy of Sciences over the past twenty years. I also wish to thank her for hosting the wonderful dinner which preceded the symposium. I am also grateful to all the participants, who not only behaved very well at the symposium (archaeologists can be a wild bunch!), but also transformed their oral presentations into generally very good written chapters. The quality of this volume has been assured by a thorough and exhaustive process of anonymous peer review for each chapter, undertaken by three outside experts in the specific field relating to each paper. I thank those hardy reviewers, many of whom have asked to remain nameless, very much.

Finally, I wish to express my gratitude to three people who were critical to the success of the symposium and to the physical production of this book. Nancy Gee attended completely to all the logistics of the symposium, and in doing so relieved me of an immense responsibility. The success of the symposium itself was made possible by her expert efforts in organizing transportation and accommodation for the participants, and in making all the arrangements for the symposium itself. Vivian Young was responsible for the design of the book cover and the chapter format, both of which take their inspiration from her designs for the symposium brochure and program. It was a joy to work with such a gifted artist. Rachel Wolf, who has acted as my editorial assistant in the production of this book, was responsible for the immense tasks of corresponding with the authors on editorial matters, and formatting and typesetting the book in preparation for publication. The beautiful layout of the text and illustrations, and the punctiliously edited text owe everything to her unflagging and good-humored efforts. I hope that you find this book as rich and stimulating to read as I found it to edit.

Nina G. Jablonski
San Francisco
January 15, 2002

CHAPTER ONE

INTRODUCTION

CHANGING PERSPECTIVES OF THE FIRST AMERICANS: INSIGHTS GAINED AND PARADIGMS LOST

Nina G. Jablonski



"Far from being a novel one, some aspect of the question of the origin of the American race has come to be almost perennial, and it acquires greater interest as increase in our knowledge of the subject offers new points of approach. At what epoch man came to our continent from a former home; how he made his way hither; and his history since he came, are questions that possess greater and greater attraction as the science of man becomes broader and deeper. If we accept the theory that man originated in the Old World, it is evident that his colonization of America is a question of mode of migration, which resolves itself into a geographical or a geological one. An adequate solution to our problem must draw contributions from several sciences — geology, geography, comparative anatomy, and culture history." (Fewkes 1912:1–2)

"The program calls first for a presentation of the historical side of the subject, or, strictly speaking, for a brief history of the opinions that have been held on the question of the nature and origin of the American natives since their discovery. This history, it may be said at the outset, is largely one of speculation, fettered on one side by ignorance and on the other by ancient traditions." (Hrdlicka 1912:5)

Twenty-first century anthropologists like to think of themselves as integrative thinkers who are pioneering new, interdisciplinary and multidisciplinary approaches to some of the perennial questions of the discipline, such as the peopling of the Americas. Happily, the ninety-year-old passage from Fewkes disabuses us of that arrogant notion. And, the passage of the same vintage from Hrdlicka will also sound fresh, in content, if not in style. Anthropologists, especially those trained in the American academic tradition, have been integrative scientists throughout most of their history. The only thing that really sets the anthropologists of today apart from those of Fewkes's time is that they

have more to integrate. Information relevant to an understanding of the peopling of the New World comes to us today not only from the disciplines named by Fewkes, but from many other areas of study. The fundamental questions posed by Fewkes are, however, the same as in his day. They have been visited many times since the beginning of the discipline, and the literature on the subject is voluminous (see, e.g., Fewkes 1912; Howard, 1936; Owen, 1984). The contributions to this volume represent a continuation of this long tradition.

As this chapter is written, in the early 21st century, we have tremendous advantages over our colleagues of even just 20 years ago. The most important of these is information. We are no longer restricted to examination of information from the “traditional” anthropological disciplines of archaeology or osteology. We have the potential — not always exercised, mind you — to synthesize information from these fields as well as many others, including paleoecology, geochronology, odontology, linguistics and molecular biology. The chapters in the current volume represent more of an encouraging progress report on the peopling of the Americas rather than the last word.

The Fourth Wattis Symposium on “The First Americans: The Pleistocene Colonization of the Americas” was conceived with the notion of bringing together the latest evidence that pertains to all the issues surrounding the earliest peopling of the New World. Seemingly intractable controversies and entrenched debates continue to characterize this area of inquiry: Hrdlicka's fetters of ignorance and “ancient tradition” have evolved in ninety years, but they have not disappeared. Fortunately, the reader will find in this volume that the current state of knowledge about this important phase of human history reflects many new insights gained from new bodies of data. Even if Fewkes's questions haven't been answered completely or Hrdlicka's lament rendered unfounded, the peopling of the Americas is now understood in greater detail than ever before.

In the context of the five-million-year history of the human lineage, the peopling of the Americas is, in some respects, of limited interest. After all, human colonization of the New World occurred in the latest Pleistocene and early Holocene, long after anatomically modern humans were established in the Old World. The peopling of the Americas did not, therefore, involve the origin or extinction of a new hominid species or the interaction of two hominid species. And, because of the recency of the event, we also see little evidence of biological adaptation to New World environments (Brues 1977; Brace *et al.* 2001): There hasn't been much time for this to occur, and most of the adaptations that humans have made to life in the varied environments of the New World have been cultural not biological. What is of great interest and significance, though, is that the humans entering the Americas in the Late Pleistocene were entering a continental mass that previously knew nothing of humans or human cultures. Like the colonization of

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Australia that preceded it, the peopling of the Americas was an ecological event of enormous magnitude. Suddenly, modern humans with a sophisticated culture moved onto unknown landscapes, where the challenges caused by their ignorance of new habitats were more than compensated by their own adaptability and the many riches the new continent had to offer. Fascinating too are the smaller-scale biological phenomena that occurred as small human groups entering the Americas underwent “microevolutionary” changes, resulting in subtle genetic differentiation from their parent stocks. This was accompanied by a tremendous diversification of languages, a demonstration of the dramatic difference that can obtain between rates of biological and cultural evolution. Perhaps the most engaging, but least discussed, of the significant issues surrounding human colonization of the Americas is the topic of the human extinctions that no doubt occurred. It is easy to imagine that many small founding groups or populations met with hard times, as the result of rapid environmental change, a shortage of appropriate mates, or even new mushrooms. Paleontologists often try their best to connect fossil populations with one another, or with living populations, in the absence of compelling evidence or theoretical reasons for doing so. The peopling of the Americas occurred at the end of the last Ice Age, when ecological times were tough, even for clever, adaptable, culture-bearing hominids. Not all populations survived, nor did they all give rise to modern Native Americans. Some of the populations that are preserved in the paleontological and archaeological records of the Americas no doubt represent extinct demes. Many more populations that made it to the Americas probably left no trace of their existence.

Because of the intense interest among, especially, American scholars in the peopling of the New World over the last 150 years, many controversies have arisen over as investigators have sought to answer Fewkes's simple but difficult questions. The intensity of investigation into each of these questions has resulted in the whipping up of veritable tempests of debate that have swirled through generations of scholars and their students. The stormiest of these certainly concerns the exact date of arrival of the first humans into the Americas. Prior to the 1960s, it was widely considered that colonization of the Americas occurred 30,000 years ago or more (see Owen 1984, for a summary of this evidence). With the arrival in the 1960s and 70s of better techniques for determining absolute ages of events in the geological record, however, much more careful attention has been paid to establishing an accurate and reproducible chronology of human settlement in the Americas. Since the mid-1960s, the Clovis site of New Mexico and the Clovis fluted tool complex, dated between 12,000 and 11,000 yr BP has been the “gold standard” against which all other claims for early arrival in the Americas have been judged. Since then, literally dozens of allegedly pre-Clovis sites have been paraded through the literature (Owen 1984; Marshall 2001) with only a very few surviving with

their pre-Clovis hopes intact. Of the fetters that shackle the study of human prehistory in the New World, this is one of the strongest, because debates over geochronology have, in recent years, come to dominate all other areas of discourse in the study of early American prehistory. This is not to say that the insistence upon a robust geochronological framework is not important: It most certainly is. But many of the disputes and the disputants have more of the character of Greek tragedies than scholarly exchange. Controversies about the dating of the first colonization of the New World by humans are given attention in this volume, but they are not the dominant theme. Other issues, such as the biological origins of the first Americans, the mode and routes of their colonization, and their ways of life in the New World have been given relatively greater consideration. One of the topics of greatest interest to naturalists and anthropologists of the 19th and early 20th centuries was that of whether the aboriginal Americans had evolved in the Americas *in situ* or were migrants from other continents, even representing remnants of the Lost Tribes of Israel (Hrdlicka 1912; Owen 1984). Over the intervening years, it has become clear from, especially, the study of biological evidence that the original Americans came from Asia. For most of the last century, the questions have been narrowed down to how and when they got to America, who exactly they were, and how they made a living. That is where this book begins. In “Setting the Stage: Environmental Conditions in Beringia as People Entered the New World,” by Scott Elias, we learn about the nature of the environments that existed in the latest Pleistocene and earliest Holocene on Beringia, that vast Ice-Age land bridge between far northeastern Asia and far northwestern North America plied by many migrants to the New World. The task of recreating this landscape is not easy, and Elias does so with, arguably, some of the organisms best suited to the task — insects. Many of the insects and, specifically, the beetles of the temperate and polar regions are remarkably narrowly adapted to their environments. Elias uses this high level of habitat specificity to great advantage in reconstructing the rapidly changing environments of Beringia in the period between 13,000 and 10,000 yr B.P., when humans were beginning to make their way overland to the Americas.

There then arises the seemingly innocent question of what the first migrants did when they arrived on their new continent. This topic is tackled by David Meltzer in his chapter, “What Do You Do When No One's Been There Before? Thoughts on the Exploration of New Lands.” In this thought-provoking chapter, Meltzer develops two main questions: How did the earliest arrivals come to grips with what was what in their environment? and how did the initially small human populations maintain contact with each other for purposes of finding mates? In his chapter, he develops important ideas about how “landscape learning” must have occurred in the earliest human migrants, and

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how occasional communication between groups resulted in the exchange of vital commodities — information about food and mates.

For most of the last century, most scholars have theorized or at least assumed that humans migrated to the New World overland, via the Bering land bridge. Although migrations by sea were mooted, most theories of colonization by boat, either via coastal or mid-ocean routes, were considered improbable at best (see Owen 1984 for a review of the early literature). Fortunately, the theory has been dusted off and given new respectability by Jon Erlandson. In his chapter, “Anatomically Modern Humans, Maritime Voyaging, and the Pleistocene Colonization of the Americas,” Erlandson points out that coastal migrations have been dismissed out of hand for lack of evidence. He makes the convincing argument, however, that rising sea levels since the Late Pleistocene have eradicated much of that evidence. Erlandson has spent much of the last two decades exploring steep shoreline sites along the North American coast, and has found considerable archaeological evidence for latest Pleistocene and early Holocene occupation there. He makes the cogent argument that there must be more such evidence, even if it is now inundated.

The nature of the human populations that first peopled the Americas is the subject of the next two chapters. D. Gentry Steele and Joseph Powell examine the cranial osteological evidence for the nature of the founding populations in their chapter, “Facing the Past: A View of the North American Human Fossil Record.” In their chapter, Steele and Powell undertake multivariate analyses of the measurements of fossil and modern crania. Their sample includes most of the fossil crania identified as latest Pleistocene or early Holocene Americans and a wide range of modern human populations. Their analysis reveals that the ancient Americans were a heterogeneous lot with respect to cranial shape, and that not all ancient North American populations have obvious similarities to the modern counterparts.

Christy Turner attacks the same problem from a different angle in his chapter, “Teeth, Needles, Dogs, and Siberia: Bioarchaeological Evidence for the Colonization of the New World.” Turner, who has long utilized dental morphological characteristics to infer patterns of human interrelationship and migration, draws upon a combination of dental and archaeological evidence in his review. He contends that most, if not all, of the founding populations of the Americas came from Siberia, and that they appear to have arrived in three Late Pleistocene migration events. Archaeological evidence pertaining directly to the timing of the arrival and adaptations of the earliest Americans is the subject of the next two chapters. In “The Migrations and Adaptations of the First Americans: Clovis and Pre-Clovis Viewed from South America,” Anna Roosevelt, John Douglas, and Linda Brown examine the growing evidence for habitation of South

America by humans at or before Clovis times. They argue that not only are these sites competitive with Clovis in terms of their geochronology, but they preserve peoples that followed a different lifestyle. Their thorough review questions the theory of "Clovis as Ancestor" and offers in return "Clovis in Context." Marshalling copious geochronological, archaeological, and paleobotanical evidence, they demonstrate that most early South American populations were not big game hunters, but foragers and hunters of small game.

A similar theme is developed by Tom Dillehay and Jack Rossen in, "Plant Food and its Implications for the Peopling of the New World: A View from South America." They argue that the absence of preserved plant remains from many archaeological sites has prevented scientists from appreciating the importance of plant foods in the diets of ancient peoples and has caused them to dwell inordinately on stone tools and the butchered remains of large animals. Using the Chilean site of Monte Verde with its well-preserved plant foods as their primary example, Dillehay and Rossen demonstrate that the earliest Americans inhabited "food affluent" environments such as wetlands and forests that contained a great diversity of plant biomass, and that most of their economies were based on foraging, not big game hunting.

All contributors to this volume recognize the great antiquity of the occupation of the Clovis people in the New World. Not all, however, agree that their origins were Asian. In "Ocean Trails and Prairie Paths? Thoughts About Clovis Origins," Dennis Stanford and Bruce Bradley develop the controversial theory that the origins of the Clovis culture lie in the western part of the Old World, specifically in the Iberian Peninsula. Citing strong similarities in the shape and mode of manufacture of fluted stone points, Stanford and Bradley argue that the closest affinities between North American Clovis culture and another stone tool tradition are with the Solutrean tradition of Iberia.

Our volume on the earliest Americans concludes with two chapters that examine and apply "non-traditional" data to the problems of the nature of the earliest population(s) and the timing of their arrival(s). In "The First American Language," Johanna Nichols explores the origins of the tremendous linguistic diversity of modern indigenous peoples in the Americas by tracing the frequencies of structural elements in various languages over vast landscapes, an approach that is best described as combining linguistic typology with geography. Her reconstruction questions the relatively short time scale that archaeologists have defined and proposes that the Americas were colonized in the Late Pleistocene by Asian peoples, many of whom were originally coastal.

The molecular evidence for the colonization of the Americas, a topic that Fewkes would surely have loved, is explored by Andrew Merriwether in "A Mitochondrial Perspective on the Peopling of the New World." This examination develops

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Merriwether's idea that the Americas were colonized in a single wave, followed by a rapid differentiation of peoples *in situ*. This book does not clearly answer any of Fewkes's simple questions that opened this chapter. What it does allow readers to do is to learn how to judge the evidence relevant to those answers for themselves. Today, the study of the human colonization and occupation of the New World brings one into contact with many kinds of data, many theories and many scenarios: Evidence exists for and against the presence of humans in the New World before 12,000 years ago. Evidence exists for and against the hypothesis of multiple migrations of humans into the New World. Evidence exists for and against the hypothesis that humans used coastal as well as hinterland routes to populate the Americans. Evidence exists for and against the source population for New World migrants coming from Siberia. The lists of evidence and refutations go on and on and, not surprisingly, people new to this topic find it all quite bewildering. It would be presumptuous to state that the surfeit of new and old data presented in this volume leads to a consensus as to the nature, mode and tempo of the human colonization of the New World, but we are closer to achieving this end than ever before. Armed with the knowledge derived from chapters of this book, it should be possible to face this daunting collection of evidence with hope and equanimity. We are closer to the answers to Fewkes's questions than we suspect.

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CHAPTER TWO

SETTING THE STAGE: ENVIRONMENTAL CONDITIONS IN BERINGIA AS PEOPLE ENTERED THE NEW WORLD

Scott A. Elias



Archaeology is far more than the study of ancient artifacts. Archaeological research aims at unraveling the history of ancient cultures and the forces that brought change to ancient ways of life.

We know little of the earliest cultures in the New World, because these people trod lightly and moved rapidly across the landscape, leaving behind only fragmentary evidence of their culture. Apparently they rarely made any permanent camps or built any structures beyond simple stone hearths and tent rings. Our knowledge of them is based mainly on their stone tool kit. From this we deduce that the first human inhabitants of the New World were hunter-gatherers who moved about the landscape, mainly in pursuit of big game animals. Independent from the archaeological record, we know that the Late Glacial period (*ca.* 13,000–10,000 yr B.P.) was a time of environmental upheaval, especially in Beringia. The aim of this paper is to describe Beringian environments during the Paleoindian Period, the transition interval between the Late Pleistocene and the Holocene. In so doing, I hope to set the stage for the Paleoindian migration into Alaska and the Yukon Territory. In other words, my aim is to provide an environmental context in which to examine Paleoindian lifeways at their point of entry into the New World. This is a challenging task. As Schweger and colleagues (1982) so eloquently put it, “To recreate a landscape, green with life or windswept and barren, and then repopulate it with animals and men is a formidable task.”

Late Pleistocene Physical Environments of Beringia

Alaska, the Yukon Territory of Canada, and northeastern Siberia share a unique Ice Age history. Nearly all other high latitude regions of the Northern Hemisphere were covered by ice sheets during Pleistocene glaciations, but the lowlands of the aforementioned regions remained unglaciated during much of the Pleistocene. Global sea level

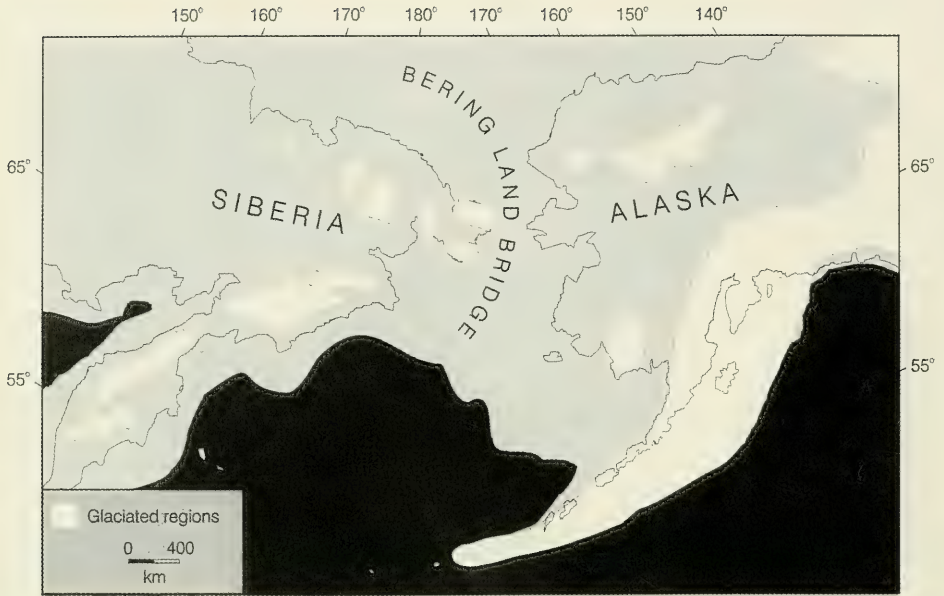


FIGURE 1. Map of northwestern North America and northeastern Asia, showing the boundaries of Beringia during the last glaciation.

was approximately 120 meters lower than today (during the last glaciation). The continental shelves between Alaska and Siberia are mostly less than 100 meters below modern sea level, so, during the last glaciation those shelves were exposed as dry land, forming a land bridge linking the unglaciated lands of Siberia, Alaska, and the Yukon. The huge, largely unglaciated region is known as Beringia (Figure 1).

Full glacial environments

It is generally believed that Beringian lowlands remained ice-free because the Bering Land Bridge blocked Pacific moisture from entering many interior regions. Paleoclimate studies have shown that Beringia had sufficiently cold climate to develop and sustain glacial ice sheets, but this region lacked sufficient moisture to grow glaciers. For instance, much of lowland Alaska bears evidence of ice wedges and other relict permafrost features that formed in the Late Pleistocene (Péwé 1975). These features show that Alaska experienced temperatures that were sufficiently cold to foster the growth of glaciers during the Late Pleistocene. On the other hand, large-scale Late Pleistocene loess deposits

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and sand dunes attest to the relative aridity of climate. Pleistocene environmental conditions in Beringia were unlike any in the modern world, because the environmental factors that contributed to the formation of Beringia (lowered sea level and continental ice sheets) are no longer in existence. Based on climate models, Bartlein and colleagues (1991) listed the important factors that controlled Beringian climate in the Late Pleistocene, as follows: 1) cooling effects from the continental ice sheets to the east; 2) a split in the atmospheric jet stream, in which one part flowed north of the ice sheets, and the other flowed south of them; 3) changes in insolation at high latitudes in the Northern Hemisphere through the various Milankovitch cycles; 4) reduced CO₂ concentrations in the atmosphere during glacial intervals and increased CO₂ concentrations during interglacial intervals; 5) sea ice, sea surface temperature and salinity changes; and 6) cooling effects of late-lying glacial ice on adjacent land areas. These factors interacted in many ways, only a few of which are well understood by paleoclimatologists. Some of these factors had unique impacts on Beringia. For instance, the split flow of the jet stream probably brought a stronger flow of southerly air into Alaska and the Yukon Territory, making summers cooler than otherwise, but perhaps making winters warmer. The combination of sea ice, sea surface temperatures, and salinity of ocean waters off the southern coast of Beringia may have brought warmer autumns and winters than exist today. Increased CO₂ concentrations during interglacial periods served to amplify the warming brought on by increased insolation. Conversely, decreased CO₂ concentrations during glacial periods would have decreased the degree of greenhouse gas warming of the atmosphere. Taken together, the various climatic factors interacted to yield intervals of interglacial and interstadial warming at 130,000–120,000 yr B.P., 110,000–100,000 yr B.P., 87,000–75,000 yr B.P., 60,000–30,000 yr B.P., and the Holocene. Low points in the insolation curve correspond with the times of mountain glacial advances in Eastern Beringia, and with the build up of continental ice sheets to the east. These intervals include 120,000–110,000 yr B.P., 75,000–60,000 yr B.P., and 25,000–18,000 yr B.P.

Estimating paleotemperatures

Paleotemperature estimates for the Last Glacial Maximum (LGM) have been made from fossil beetle assemblages in Alaska and the Yukon Territory (Elias 2000a) and northeastern Siberia (Alfimov & Berman 2000). The Eastern Beringian estimates are based on the Mutual Climatic Range (MCR) method. This method is based on the determination of a set of climatic parameters compatible with all of the species in a fossil assemblage. The first step in this procedure is the construction of a climate envelope for each species. The climate envelope data developed for this study focused on the mean

temperature of the warmest month of the year (TMAX) and the coldest month of the year (TMIN) at the locations where the species are known to occur today. The climate envelope of a species represents the set of climatic conditions for which that species is adapted. Some species of beetles (stenothermic species) have very precise climatic tolerances. In other words, they are adapted to live in a very narrow range of climatic conditions. Some of these species are found in only one small region of the world today, whereas others are found in many separate regions, such as mountaintops or isolated patches of desert, where the same climatic conditions exist in small geographic areas. Such species are the most useful for paleoclimatic reconstruction, because their presence in a fossil assemblage narrows the overlap between the species' climate envelopes to a small set of conditions. Fortunately, a number of stenothermic beetle species were found in Late Pleistocene fossil assemblages from Alaska and the Yukon Territory. Other beetles (eurythermic species) are adapted to a broad range of climatic conditions. These species are generally found throughout many regions of a continent. Their presence in a fossil assemblage rarely provides any useful constraints on the paleoclimatic reconstruction.

Not many modern beetle collecting localities are in close proximity to meteorological stations, so in order to achieve the best estimates of modern mean temperatures for these collecting sites, my colleague, Katherine Anderson (INSTAAR, University of Colorado) used a computer program that estimates climatic conditions at sites in North America, based on the nearest meteorological station to the collecting site. This computerized estimation is based on a 25 km-grid of the continent, developed by Bartlein and colleagues (1994). The climate parameters of the modern beetle collection sites were matched with the geographically nearest grid location to each collecting site. Then the climatic parameters of each of these localities for a species (usually several hundred collecting localities) were plotted on diagrams of mean July temperature (TMAX) vs. the difference between the mean July and mean January temperature (TRANGE).

The Eastern Beringian fossil assemblages yielded TMAX and TMIN estimates for the LGM and Late Glacial intervals (Elias 2000b). The fossil beetle assemblages used to prepare the MCR estimates comprise 101 identified species of predators and scavengers. To avoid potential problems with plant migration lag, no plant-feeding species were used in the MCR reconstructions. Only predators and scavengers were used to estimate past temperatures. These beetles are thought to respond more readily to climatic change, by shifting their ranges away from regions of unsuitable climate.

To standardize the results over a broad geographic region, temperature estimates are presented primarily as departures from modern TMAX and TMIN at the study sites. The paleotemperature estimates were calibrated to a modern data set, using linear regression

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equations to fit predicted to observed TMAX and TMIN values for modern localities with meteorological records (see Elias *et al.* 1999). In other words, our previous study used modern beetle assemblage data to predict modern temperatures at locations in Alaska and the Yukon Territory for which meteorological data are available, as a test of the paleoclimate method. The predictions of TMAX and TMIN that were based on the modern beetle assemblage MCR reconstructions did not match the modern TMAX and TMIN data exactly. For the warmest locations, the MCR estimates were too low. For the coldest locations, the MCR estimates were too high. We, therefore, developed the linear regression equations to adjust our beetle-generated estimates of TMAX and TMIN to the actual observed values.

One difficulty in using MCR estimates from Beringia is that the coastal geography has changed with each glacial/interglacial cycle. Glacial and interstadial sites that lie near the modern coast were subject to continental, rather than maritime climates. This appears to have affected TMIN estimates more than TMAX estimates (Elias *et al.* 1999). It is, therefore, difficult to interpret the TMIN estimates for coastal and land bridge assemblages, because changes in sea level shifted the climatic regime at these sites from continental to maritime. The land bridge was inundated by 11,000 yr B.P. (Elias *et al.* 1996). The MCR estimates vary from fairly precise to rather broad, depending on the number of stenotherms (species with limited thermal tolerances) in a fossil assemblage. Assemblages containing 3–4 stenothermic species often produce very narrow mutual climatic ranges, whereas assemblages with many eurythermic species (species with broad thermal tolerances) often yield only broad temperature estimates. TMAX estimates have an average range of 1.5°C, but a few ranges are as large as 5°C. This is an inherent weakness in the data that cannot be overcome except by additional studies of fossil assemblages from critical regions and time intervals. The calibrated estimates shown in Figure 2 are the best estimates available from the published data.

The Alaskan fossil beetle assemblages from this interval (20,000–18,000 yr B.P.) yielded a series of TMAX ranging from 5.5°C colder than modern at 20,000 yr B.P. (Bluefish Caves, Yukon) to 0.9°C warmer than modern at 18,000 yr B.P. (Bering Land Bridge Park, Seward Peninsula). The Eastern Beringian data also suggest that TMIN levels were within a few degrees of modern levels. Alfimov and Berman (2000) suggested that TMAX in northeastern Siberia was 12–13°C during the Last Glacial Maximum (LGM). These temperatures are essentially the same as modern TMAX in their study region. The authors concluded that the most important difference between LGM and recent climates in this region was increased continentality. The insect evidence thus points to relatively mild climatic conditions in Beringia during the LGM, compared with far more dramatic cooling of summer and winter temperatures in regions south of the continental ice

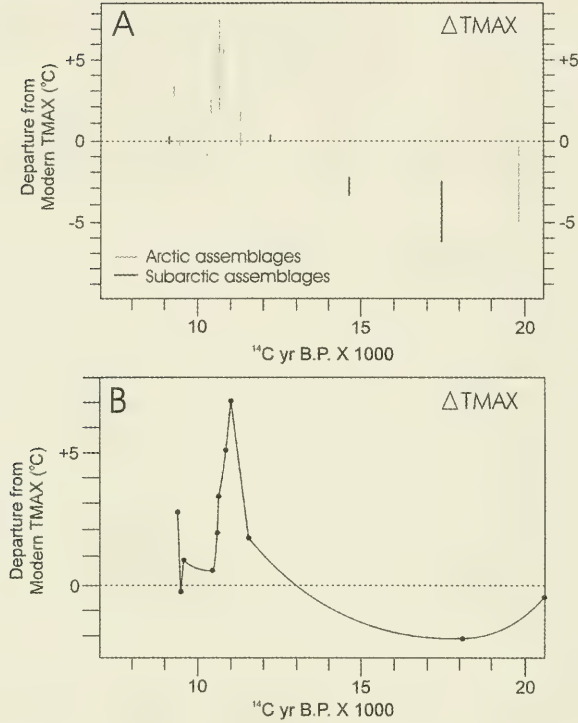


FIGURE 2. Calibrated estimates of Late Pleistocene TMAX for Eastern Beringia. Estimates in upper diagram (A) are shown as departures from modern TMAX values at study sites. The points shown in the lower diagram (B) are the calibrated results from linear regressions based on modern predicted vs. observed values (Elias *et al.* 1999).

sheets. Other lines of evidence, such as periglacial features that developed during the LGM, indicate that mean annual temperatures dropped significantly during the LGM (Hopkins 1982). Most paleoclimatologists would agree that, on a very broad scale, Beringia was relatively dry and cold with cooler summers during the LGM. More mesoscale patterns indicate east to west trends in temperature and moisture gradients with colder and drier conditions dominant over eastern Beringia (Anderson & Brubaker 1994; Lozhkin *et al.* 1993; Anderson *et al.* 1997; Hamilton 1994).

Like the paleotemperature reconstructions, there is also considerable debate as to the vegetation cover in Beringia during the LGM. Most paleobotanical studies from this interval have focused on pollen extracted from cores. The interpretation of ancient tundra vegetation based on fossil pollen spectra is inherently difficult, because of low taxo-

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onomic resolution, poor dispersal of minor pollen types, and the wide ecological tolerances of genera or species that dominated the pollen rain (Anderson *et al.* 1994). Goetcheus and Birks (2000) studied ancient land surface macrofossils preserved beneath volcanic ash at sites near the northern coast of the Seward Peninsula. They found that the vegetation was a closed, dry, herb-rich tundra with a continuous moss layer, growing on calcareous soil that was continuously supplied with loess. They interpreted the regional soils during the LGM as relatively fertile, being sustained by nutrient renewal from loess deposition and the occurrence of a continuous moss mat. It remains to be demonstrated that the vegetation preserved in Goetcheus and Birks' site represents the steppe-tundra vegetation envisioned by paleobotanists as having dominated many regions of Beringia in the Late Pleistocene. The mystery of the nature and ecology of steppe-tundra remains unsolved.

Another approach to the reconstruction of Beringian vegetation is the examination of relict patches of steppe, which are mostly in northeast Asia. Based on this approach, Yurtsev (2000) has concluded that Beringia had much greater diversity of herbaceous vegetation (grasses, sedges, and forbs) in a mosaic of steppe-tundra landscapes. Yurtsev described some of the principal types of steppe-tundra vegetation that may have existed in Beringia. Dry watersheds and slopes had cold-adapted steppe and cold and dry-adapted herbaceous and prostrate shrub-herbaceous communities. Depressions and valleys supported dry steppe-meadows and brackish-water moist meadows. Valley meadows and the bases of slopes were the most productive as pastures for grazing megafaunal mammals, because of moisture and nutrients accumulated there. Yurtsev also considered that the lowlands of the Bering Land Bridge were covered with shrub tundra, which served as a barrier for the dispersal of steppe plants and animals.

Late Glacial environments

The Late Glacial period (14,000–10,000 yr B. P.) brought a series of large-scale, rapid environmental changes throughout Beringia. Climatic fluctuations forced wholesale changes in the distribution of Beringian plants and animals, and may have played the dominant role in the regional extinction of many megafaunal mammal species. According to the fossil beetle data from Eastern Beringia (Elias 2000b), TMAX values began rising at least by 12,000 yr B.P., reaching warmer-than-modern levels by 11,000 yr B.P. In Arctic Alaska, TMAX values rose as much as 7°C warmer than modern at that time. This dramatic climate change was probably brought on by a combination of increased insolation and the flooding of the Bering Land Bridge, which brought relatively warm, Pacific waters to the northwest coast of Alaska.

The changing climate also brought about major changes in vegetation across Beringia. Pollen evidence (Brubaker *et al.* 2000; Edwards *et al.* 2000; Bigelow & Edwards 2000) shows that the herbaceous tundra vegetation that dominated much of Beringia at the end of the last glaciation gave way to shrub tundra in most regions between 14,000–12,000 yr B.P. This vegetational shift occurred at different times in different regions. In northwestern Alaska it began by 14,000 yr B.P. In Western Beringia it took place from 13,000–12,500 yr B.P. In the Mackenzie Mountain region, in easternmost Beringia, Szeicz and MacDonald (2001) found evidence of rapid climatic amelioration by 11,000 yr B.P. *Populus* (balsam poplar and or aspen) expanded in these mountains from 11,000–9000 yr B.P. *Populus* expanded north of the Brooks Range in Alaska during this same interval (Anderson & Brubaker 1994).

Pollen studies point to a climatic oscillation during the Younger Dryas chronozone (10,800–10,000 yr B.P.) in Eastern Beringia (Brubaker *et al.* 1999). Elias (2000b) found strong evidence of a decline in TMAX values during this interval, especially in arctic beetle assemblages. TMAX values cooled by almost 7 °C over a period of about 350 years (Figure 2). Bigelow and Edwards (2000) noted a reduction in shrub tundra and an increase in herb tundra in central Alaska from 10,500–10,200 yr B.P. Strong evidence for a Younger Dryas cooling has been interpreted also from pollen records from Kodiak Island (Peteet & Mann 1994). The history becomes a bit more confused in Western Beringia. Lozhkin and colleagues (1999) found no evidence for a Younger Dryas-type climatic event from most northern and eastern regions of Western Beringia. However, Pisaric and colleagues (2000) reported a possible Younger Dryas cooling in the lower Lena River basin, based on pollen evidence indicating an increase in herbaceous tundra at the expense of shrub tundra.

Coniferous forest expansion through Eastern Beringia came only in the Holocene. The only source populations of conifers available to colonize Alaska were growing in distant southern regions during the Late Pleistocene. Paleohydrological modeling by Edwards and colleagues (2000) suggests that the Late Glacial period in eastern interior Alaska was a time of relative aridity. The combination of extremely cold winters and little effective moisture may have combined to retard the expansion of coniferous forests in Eastern Beringia. For whatever reason, spruce forest did not reach the end of its migration route in southwestern Alaska until as late as 4500 yr B.P. (Brubaker *et al.* 2000).

*Late Pleistocene Megafauna of Beringia**Late Pleistocene fauna*

During the last glaciation, Beringia provided the major refuge for large mammals adapted to living in the high latitude regions of the Northern Hemisphere. Based on the fossil record, there was an abundance and diversity of large mammals that has never since been equaled in any high latitude region. The only modern ecosystem that supports a similar variety of grassland animals is the East African Savannah. There are some interesting parallels between the Pleistocene steppe-tundra fauna and the modern African fauna. In the Beringian ecosystems, the woolly mammoth filled the elephant niche. The woolly rhinoceros, probably a rare species in Beringia, filled the rhinoceros niche, and saiga antelope filled the antelope niche. The modern range of saiga antelope is presently restricted to Central Asia, where arid grassland habitats persist today. It died out in Alaska and the Yukon Territory sometime after 13,000 yr B.P., as changing vegetation patterns eliminated its steppe-tundra habitat (Harington & Cinq-Mars 1995). In place of African zebras, the steppe-tundra had Pleistocene horses. Instead of water buffalo and wildebeest, the steppe-tundra had large-horned bison and two species of musk-ox. The dominant grazers on this cold grassland were the woolly mammoths, Pleistocene horses, and large-horned bison. Caribou were also present in the Late Pleistocene. Caribou feed on grasses and other herbs, shrubs, and lichens. Thus their diet represents a mixture of browsing and grazing.

Mammoths appear to have been more dominant in Arctic regions of Eastern Beringia, whereas Pleistocene horses and bison dominated the subarctic regions (Kunz *et al.* 1999). These herbivores either became extinct at the end of the last glaciation, or, in the case of saiga antelope, they no longer live in the Beringian region. The only large true grazing mammal species still living in Alaska is the musk-ox. The other large plant-feeding mammals that remain here, such as moose, caribou, dall sheep, and mountain goat, are primarily browsers that feed on a mixture of shrubs and herbs. For instance, mountain goats feed on alpine grasses, mosses, lichens, and various woody plants and herbs. A moose's summer diet consists of a variety of plants, including pond weeds, sedges, horsetails, grasses, and the leaves of willow, birch, and aspen. In winter its diet shifts to willow, birch, and aspen twigs.

There is some intriguing evidence that the large grazing mammals of Pleistocene Beringia played a strong role in maintaining the grassy nature of their steppe-tundra habitat. Zimov and colleagues (1995) used a computer model to simulate the interactions of megafaunal mammals and vegetation in Beringia. They hypothesized that trampling

and grazing by mammalian grazers in a tundra landscape would have caused a vegetation shift from mosses to grasses. Grasses reduce soil moisture more effectively than mosses, because of their higher rates of evapotranspiration. The results of their model suggest that if herds of grazers were reintroduced into northeastern Siberia, Alaska, and the Yukon Territory, grass-dominated steppe vegetation would likewise return. Zimov and colleagues believe that the megafaunal grazers had a sufficiently large effect on vegetation and soil moisture in Beringia that their extinction may have played a major part in the shift from steppe to tundra vegetation at the Pleistocene-Holocene boundary.

Wherever there are large numbers of herbivores, there will also be predators, and the Beringian grazers were preyed upon by a variety of predators. Again, comparisons with the African Savannah fauna come readily to mind. The Pleistocene lion looked very much like the modern lion, but was somewhat larger. The saber-toothed cat was also a powerful predator, armed with dagger-like canine teeth for slicing into the neck of prey animals. Perhaps the most impressive Beringian Pleistocene predator was the giant short-faced bear. This animal stood about two meters tall at the shoulder and was three meters from nose to tail. Its long legs were adapted for running down prey. Grizzly bears can put on bursts of speed of up to 65 km (40 miles) per hour. Giant short-faced bears undoubtedly ran faster than that, but more importantly, they were able to sustain their speed over greater distances. We have no evidence that these bears sought out humans as prey, but some scientists have speculated that the New World was not a safe place for people to live until the short-faced bear died out. (See Turner, this volume, for more on this subject.) Along with the extinct predators, there were all of the modern Arctic and subarctic species, such as the polar and grizzly bear, wolverine, wolf, and lynx.

Nature and timing of megafaunal extinctions and extirpations

Recent efforts to pin down the timing of the major megafaunal extinction event at the end of the Pleistocene have placed this event at about 11,400 $\pm$ 150 yr B.P., with a statistical error of about plus or minus 150 years (Elias 1999). The dating of this event is based on 140 AMS radiocarbon dates on purified protein extracts from fossil bones of megafaunal mammals that died near the end of the last glaciation, including camels, horses, and Pleistocene bison. Mammoths and mastodons persisted beyond 11,400 yr B.P. Stafford and colleagues (personal communication, 1999) have dated the extinction of North American mammoth and mastodon to 10,900–10,850 yr B.P., so it now appears that there may have been two distinct extinction episodes. Each event probably took less than 100 years. One intriguing exception to this extinction event concerns the woolly mammoth population of Wrangel Island, a small Arctic island off the northeast coast of

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Chukotka, Siberia. Vartanyan and colleagues (1993) obtained numerous radiocarbon dates on mammoth bone collagen, showing that the last mammoths died out on Wrangel Island only about 3,700 yr B.P. Wrangel Island is unique in several ways. It was connected to mainland Siberia until about 12,000 yr B.P., when the intervening continental shelf was inundated. The modern climate and vegetation of the island closely resemble steppe-tundra environments of Pleistocene Beringia. Also, humans did not enter Wrangel Island until the late Holocene. If humans had been there earlier, they might have hunted the mammoths to extinction.

Early Human Lifeways in Eastern Beringia

The timing of human entry into Eastern Beringia

In spite of more than fifty years of dedicated research, we still do not know when or how people entered the New World. One view is that people crossed into the New World via the Bering Land Bridge and then proceeded south along an ice-free corridor in western Canada. Another view is that people traveled by boat from Siberia to Alaska, then farther south (Josenhans *et al.* 1995; Dixon 2000; Mandryk *et al.* 2000). (This theory is explored in detail by Erlandson, this volume.) Dillehay's (1986) discovery of human occupation at Monte Verde in southern Chile by at least 12,500 yr B.P. places humans in the New World well before the end of the last glaciation. The archaeological evidence clearly shows that the inhabitants of Monte Verde had already acquired very sophisticated knowledge of regional plants and animals. (See Dillehay, this volume, for further details.) Such knowledge was not obtained in just a few years, so the first occupation of the Monte Verde region likely occurred well before 12,500 yr B.P. All of this necessitates human migration out of Asia well before 13,000 yr B.P. At the end of the last glaciation, the opening up of an ice-free corridor between the Laurentide and Cordilleran ice sheets is now believed to have happened only by about 12,400 yr B.P. (Catto 1996). It would appear, then, that people had either to move south from Beringia before the LGM (*e.g.*, during the mid-Wisconsin interstadial period between 60,000 and 30,000 yr B.P.), or that they had to enter South America by a different route.

One possible scenario is that people traveled by boat along the Pacific coast of the Americas. The near-shore waters of the North Pacific undoubtedly provided a rich, constant source of food, including marine mammals, fish, and shellfish. Successive generations of marine-adapted peoples could have traveled from the coasts of northeastern Asia to southern South America, harvesting seafoods along the way. Geologic evidence (Josenhans *et al.* 1995; Mandryk *et al.* 2000) indicates that parts of the British Columbia

coast were ice-free during the late Wisconsin interval, allowing migrating peoples access to the resources of coastal landscapes.

Whether or not Beringia played a key role in the peopling of the rest of the New World, the human colonization of interior Eastern Beringia began before 12,000 yr B.P., according to archaeological evidence from the Tanana and Nenana River valleys (Hoffecker *et al.* 1996). Three possibly older cave sites have been found in Eastern Beringia: Bluefish Caves, Lime Hills Caves, and Trail Creek Caves. Paleoindian archaeologists have not reached a consensus about the validity of these sites, although there is a reasonably good case for the human occupation of Bluefish Caves by 15,000 yr B.P. (Ackerman 1996). Additional archaeological research may push the date of earliest human occupation back even further. The bulk of the Paleoindian archaeological evidence in Beringia falls within the Late Glacial and early Holocene intervals, so this paper addresses that time period.

The big game hunting tradition in Beringia

As we have seen, the late Wisconsin glacial interval was a period of rapid environmental change that saw wholesale changes in regional vegetation patterns and the extinction of many megafaunal mammals in Beringia. These large mammals were the chief prey of early hunters, so their extinction undoubtedly had an impact on human populations, forcing the development of new hunting strategies and other changes in lifestyle. The climatic changes of this glacial interval may have forced the extinction of such grazers as mammoth and horse, but it seems to have favored other taxa such as bison, elk, and caribou, although the first two of these died out in Alaska and the Yukon during the early Holocene. The stone tool kit left behind by the first humans in Eastern Beringia can tell us only so much about their lifestyles. Most Late Pleistocene archaeological sites in Eastern Beringia contain few faunal remains. The exception to this rule is the Broken Mammoth site, in the Central Tanana Valley (Figure 3). Faunal data from this site demonstrate that people utilized a wide variety of animals for food, including small game, waterfowl, and fish (Yesner *et al.* 1992). We know more about the food habits of the inhabitants of the Broken Mammoth site than we do for most other Beringian sites because the Broken Mammoth site has exceptional preservation of organic materials. The Broken Mammoth data serve as a reminder of how little we know about these early inhabitants and their lifeways.

I would like to end this paper with a more speculative discussion concerning human survival in Beringia. It is difficult to imagine hunter-gatherers living in any part of Beringia without wood to use for fires. From perhaps 80,000 to 12,000 yr B.P., most of

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FIGURE 3. Beringian archaeological and paleontological sites discussed in the text.

Beringia lacked both conifers and tall deciduous trees. Shrub birch, alder, and willow may have been the only woody plants in most of Beringia during the last glaciation. Even though Beringia had abundant game animals to satisfy the dietary needs of hunter-gatherers, it would still have been an exceedingly cold place for humans to live, especially in winter. As far as is known, these people lived in tents made from animal hides. How did they keep their tents warm when the air temperatures dipped to -40°C ? In fact there is very little evidence that people lived in Western Beringia during the last glaciation, even though archaeological evidence has demonstrated human habitation of other regions of northeast Asia at that time (Pitul'ko 2000). The most reliable evidence suggests that Western Beringia was not inhabited until about 13,000 yr B.P. It could well be that the timing of the first appearance of people in Beringia was controlled mainly by the climatic amelioration that took place during the late Wisconsin glacial interval. Even if large trees were not yet established in most parts of Beringia until a few centuries later, the unin-

dation of the Bering Land Bridge would have brought another precious resource to the coasts of Beringia: driftwood from the Pacific coast regions further south.

The only other useful source of heat for Late Pleistocene peoples in treeless regions of Beringia would have been the bones of large mammals. Burnt bones and ashes have been found in many Paleolithic sites in Eastern Europe; many northern regions were treeless during the LGM. However, such bone resources may not have been as readily available in Western Beringia, except in large basins such as that of the Kolyma River. Such basins tend to accumulate the skeletal remains of large mammals, and permafrost conditions preserve the fatty contents of bones, allowing them to burn. But perhaps human access to the Kolyma basin was blocked by too many kilometers of treeless, boneless landscape in eastern Asia during the last glaciation. The highlands that separated more southerly Asian human populations from the Kolyma basin were perhaps too great a barrier to cross without a ready source of fuel for heating.

Abstract

Like all archaeological issues, the peopling of the New World must be placed in a paleoenvironmental framework. Environmental pressures probably played the dominant role in shaping the timing and direction of human migration into Alaska from Siberia. From the archaeological evidence currently at hand, it appears that the first human migration across the Bering Land Bridge took place just as regional climates were warming at the end of the last glaciation, about 12,000 years ago. The cold, arid climate that characterized the height of the last glaciation (ca. 28,000–14,000 yr B.P.) appears to have kept both eastern and western Beringia (unglaciated regions of northeastern Siberia) essentially treeless, and there is little or no evidence that people inhabited any part of the Beringia during that period.

Between 12,000 and 10,000 yr B.P., bands of hunter-gatherers became established throughout most of Alaska north of the Alaska Range. This was a period of environmental changes on a colossal scale, many of which would have been perceived by the human inhabitants. Over a period of perhaps a few decades, the Bering Land Bridge was inundated. This, in turn, brought warm, Pacific waters into contact with the Arctic Ocean, establishing oceanic circulation patterns that had been blocked for about 80,000 years. In much of Eastern Beringia (unglaciated regions of Alaska and the Yukon Territory), an extremely continental climate gave way to a more maritime climate. In Arctic Alaska (by 11,000 yr B.P.) average summer temperatures rose to levels as much as 7°C warmer than they are today. This dramatic warming was followed by an abrupt

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reversal, synchronous with the Younger Dryas oscillation in the North Atlantic regions. Many of the Pleistocene megafaunal mammals were extinct by 11,000 yr B.P. Their demise probably forced people to adopt new hunting strategies and different game animals. It remains unclear whether human hunting contributed significantly to the extinction of megafaunal mammals in the New World.

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CHAPTER THREE

WHAT DO YOU DO WHEN NO ONE'S BEEN THERE BEFORE? THOUGHTS ON THE EXPLORATION AND COLONIZATION OF NEW LANDS

David J. Meltzer



Back in the old days, say about three years ago, we had a pretty compelling scenario for the peopling of the Americas.¹ We believed the first Americans came out of northeast Asia during the latest Pleistocene, crossing the Bering land bridge into Alaska during a period of lowered sea-level. For a time, the massive North American ice sheets blocked their way south, but after the Laurentide and Cordilleran glaciers melted back (say ~12,000 years ago²), a group or groups of these hunter-gatherers sped south through the newly opened “ice-free” corridor between them (Wright 1991). Once they reached the unglaciated lower 48 states, they radiated out across the length and breadth of North America with what appears to be archaeologically-breathtaking speed (*e.g.*, Haynes 1964, 1992).

By 11,500 years ago, they’d arrived at a spring-fed pond just south of Clovis, New Mexico, where their archaeological traces were first found in the 1930s — associated with the bones of now extinct Pleistocene megafauna, particularly mammoth (Howard 1936; see historical summary in Boldurian & Cotter 1999). Soon thereafter, Clovis and Clovis-like materials are found throughout North America in a range of environments, from the southeastern mixed deciduous forests, through the Plains grasslands, to the coniferous forests of the Pacific coast. No subsequent North American occupation would ever again achieve such a wide distribution. But they didn’t stop here: As the *traditional* view had it (*e.g.*, Lynch 1983), descendants of Clovis continued on to South America, but developed different artifacts and tools en route — so they were no longer readily recognizable as Clovis (Morrow & Morrow 1999; but see Dillehay *et al.* 1992) — and arrived at Tierra del Fuego within a millennium of leaving Alaska (Whitley & Dorn 1993).

That they traversed North America in what may have been less than 500 years (but see below) is all the more remarkable given the landscape: The Clovis colonizers arrived

at a time of extraordinary environmental upheaval, one that saw massive mammalian extinctions, the dissolution of biotic communities that had been in place for tens of thousands of years, and rapid changes in climate (*e.g.*, FAUNMAP Working Group 1996; Martin & Klein 1984; Wright 1991). And yet they seemingly coped with such adaptive challenges with ease: Their tool kit — including its signature fluted spear points (Figure 1) — is surprisingly uniform across the continent (Haynes 1982; Kelly & Todd 1988). Its apparent lack of variability not only gave added testimony to the radiocarbon evidence of a rapid radiation (which evidently lasted such a short time that few new artifacts were invented during the process), it also implied an underlying uniformity of adaptation — big-game hunting. Chasing mammoths, it was argued, enabled these hunter-gatherers to hurdle ecological boundaries (*e.g.*, Kelly & Todd 1988; Mason 1962). Some pushed the traditional scenario further, arguing that intense predation on mammoth and mastodon, and other Late Pleistocene big game animals, was driving these animals to extinction, and their disappearance propelled Clovis hunters ever-southward in search of prey (*e.g.*, Martin 1973).

The idea of highly mobile, wide-ranging, big-game hunters, whose arrival was tied to the rhythms of continental glaciation, made perfect sense — for a while. But there were always nagging doubts about this scenario, doubts which in the last decade grew much stronger. It was difficult to accept the idea that colonizers utterly new to a landscape could spread so rapidly under such complex climatic and environmental conditions (Whitley & Dorn 1993; but see Beaton 1991). Their points and tool

FIGURE 1. A Clovis projectile point from the type site (Blackwater Locality No. 1). The original specimen is ~11 cm in length. While these lanceolate forms vary considerably in technology and morphology, they share a suite of attributes, the most diagnostic of which are the flute scars, the remnants of flakes removed from the base that traveled toward the tip. Fluting on Clovis and closely related eastern forms generally extends no further than a third of the way up the face of the point (in the illustrated specimen, the flute scar is ~2.4cm long). Finished points are generally ground smooth along the base and lower edges, presumably to facilitate their hafting (attachment) to a bone, ivory, or wood handle. Like most such specimens, the illustrated one is made of high-quality chert, obtained at a source hundreds of miles distant from the site in which it was found. (Drawn from a cast by Frederic Sellet.)



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kits proved not to be quite as uniform as they appeared at first glance (Meltzer 1993). The archaeological evidence for big-game hunting, the presumed driving force behind that expansion, proved to be localized, not continental in scale (Meltzer 1993b). Clovis tastes, it appeared, more often involved less risky and slower-moving prey species — like turtles (Johnson 1991; Stanford 1991). No surprise there: Successful foragers well understood that to be successful, they had to minimize risk — the risk of coming home empty-handed, or the risk of injury or death. While Clovis groups could and did occasionally bring down mammoths, it was not to the exclusion of other, smaller, and more readily exploited prey species.

Then there was the problem of Clovis origins. Despite half a century of searching, no obvious Clovis progenitor has revealed itself in Alaska, let alone Siberia and north-east Asia (Bonnichsen 1991; Morlan 1991; but see Goebel *et al.* 1991; and King and Slobodin 1996). (And as a result, there are now very provocative claims of a far different source for these archaeological cultures; I will return to the matter of Clovis origins below.)

But most troublesome of all for the traditional scenario, there were frequent claims of a *pre-Clovis* presence in the Americas. These claims came not just from archaeology, but also linguistics and genetics (*e.g.*, Nichols 1990; Torroni *et al.* 1993). The latter derived their pre-Clovis ages from patterns in the languages and genes of modern Native peoples (see Merriwether, Nichols, this volume). Actual physical evidence of a pre-Clovis presence, of course, must come from the sites and artifacts in the ground, and for the last several decades virtually every field season brought forth a new contender.

Some of those sites, like Calico Hills in California, ostensibly upwards of 100,000 years old, were championed by the formidable Louis Leakey — fresh from his triumphs in Olduvai Gorge and eager to revolutionize New World archaeology as well (Leakey *et al.* 1968; but see Morell 1995:362–368). Others featured less well known characters, but equally old sites (see listings in MacNeish 1976; Morlan 1988). All such sites were heralded with great fanfare, and initial press releases spoke in glowing terms of genuine artifacts in well-dated site contexts, 20-, 35-, or even 50,000 years old. But then, inevitably, the site tumbled down the slippery slope of what I came to call the *pre-Clovis credibility decay curve* when it was learned the supposed artifacts were more likely naturally flaked stone, the dating technique was experimental and unreliable, or the site's deposits were so hopelessly mixed that alleged ancient artifacts were found associated with more recent remains.

Most pre-Clovis claims had a shelf-life of about a decade (Martin 1987), and so many of these contenders failed that the archaeological community grew highly skeptical of any and all pre-Clovis claims. In the face of that skepticism, the first site to break the

Clovis barrier would have to not just *meet* but *exceed* the criteria by which early sites are judged (Meltzer 1995:33). Now it appears, thanks to Tom Dillehay's recently published (1989, 1997) work at the Chilean site of Monte Verde, we have that evidence.

Although Monte Verde is only slightly more than a thousand years older than Clovis, its great distance from Beringia points to an initial arrival in the Americas much earlier than 12,500 years ago. How much earlier depends on a host of variables, like *which* route the ancestral Monte Verdeans took, whether coastal or interior, *when* those routes were open, *how* rapidly and by what adaptive means these groups traversed an increasingly unfamiliar landscape, and so on. Some (me included, see Meltzer 1997) have guessed they might have first entered the New World over 20,000 years ago, but that's just a (some-what) educated guess. It's not a real number.

Monte Verde puts the peopling of the Americas in a whole new light, and raises anew a raft of questions about where these first Americans came from, who they're related to, how early we might be able to push back their entry, whether they came by land or by sea, how rapidly and by what methods and through which habitats they traversed the hemisphere, and so on. But what it doesn't do, not yet anyway, is help us much with Clovis.

Thinking about Clovis

Recall that one of the weaknesses of the Clovis-first scenario was its inability to explain the sudden archaeological appearance of Clovis. Of course, were there a large pre-Clovis population in North America, then one could argue that the sudden appearance of Clovis points was merely the diffusion of a new technology across an existing population. But that implies an unprecedented rate of diffusion not seen again until the invention of the hula-hoop, and of a technique (fluting) that (like the hula hoop) "was not all that revolutionary in the first place and that died out relatively soon thereafter" (Haynes 1971:10; though it's perhaps useful to add that the fluting technology was around in some form for a thousand years — a far longer showing than hula hoops). Further, diffusion demands a substantial pre-Clovis presence in North America — of which we have traces, but which we certainly would hope to have seen a greater presence by now, but haven't (Meltzer 1995:29; Storck 1991).

Complicating the matter, for whatever it is worth comparing assemblages so widely separated in time and space, there are no obvious historical or technological links between the pre-Clovis age complexes of South America and the Clovis assemblages of North America. It looks as though Monte Verde and Clovis represent distinct archaeological traditions and separate migratory pulses. The possibility these are separate migra-

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tions comes as no surprise: Given the absence of barriers to cross-Beringian traffic (Meltzer 1995), and the long period in which potential source populations were present in northeast Asia (Derev'anko 1998; Goebel & Askarov 1995; Hoffecker 1996), we would expect there to be many migrations — a flow or dribble of populations — from Asia to America. And back.

More complicating still, the geographic expansion of Clovis seemingly occurred quickly across a wide area (archaeologically speaking), based on the tight radiocarbon ages for this occupation, and the similarity of Clovis and related artifact forms and tool kits. These raise the intriguing possibility that their access to large areas of North America was essentially unrestricted — that they encountered few (if any) other people along the way, despite an apparently earlier migratory pulse into and through North America by ancestral Monte Verdeans.³ Perhaps. Of course, one must be mindful of the fact that there is variability in Clovis artifact technology, function, and style, the significance of which we (as archaeologists) do not yet understand. This is largely because we have yet to securely link patterns of material culture (distinctive artifact styles, say), with populations on the ground (be they social or cultural groups, linguistic units, or mating networks — not all of which, of course, are even necessarily synonymous with each other). We assume they are related, but they may not be in the straightforward ways we think.

Furthermore, recent calibration of the radiocarbon curve for this period suggests that radiocarbon years may be compressed relative to calendar years, so Clovis groups may not have radiated as quickly in real time — a point anticipated by Haynes (1971; see Meltzer 1995; Taylor *et al.* 1996). How much longer the process may have taken is uncertain because of oscillations in the ^{14}C reservoir during the Late Pleistocene (Edwards *et al.* 1993; Hughen *et al.* 1998). Still, I suspect when the calibration issue is ultimately resolved, it will be the case that Clovis groups moved relatively rapidly — I consider traversing a continent in a thousand years a relatively rapid process.

All that said, for the sake of the discussion I will make just that assumption: That Clovis groups did move far and fast across an unknown continent. I do so because at the moment, I am more interested in how or why they moved fast, rather than how fast they moved. I want to explore just how viable such a rapid expansion may have been, by thinking about what might have been the adaptive challenges they faced, and how they may have met them.

So much of our attention up to now has been on the Clovis/pre-Clovis debate, only recently have we begun to explore these and other questions of the colonization process (*e.g.*, Beaton 1991; Kelly & Todd 1988; Meltzer 1995). While some progress has been made, what follows is by no means the final say on any of these matters. What follows

is based on my own recent model-musings (Meltzer 1998), in which I have tried to understand what the process of colonization might look like in terms of prey selection, habitat use, niche expansion, and patch choice (and the answer is, it looks fairly complicated).

What I want to do here is focus on two components of that larger model, components that I think are critical to the colonization process: *demography* and *landscape learning*. As you'll see, these matters are relevant to any colonization of an empty landscape, though I will explore them in terms of Clovis, for that's the archaeological record I know best, and because Clovis is an especially interesting, if not unusual colonization episode, given the apparently breathtaking speed with which it occurred.

There are, of course, other examples of archaeological or ethnographic groups moving quickly across landscapes; but scarcely any examples of pedestrian groups moving that fast across an *empty* landscape — let alone an empty continent.⁴ The best illustrations of those come from the Arctic (not surprisingly so, given this is an environment that lends itself to rapid traverses). Consider the cases of the Paleo-Eskimo, and the Thule.

The Paleo-Eskimo groups (badly misnamed: As McGhee notes there is nothing to demonstrate they are ancestral Eskimo, or even spoke an Eskimo language), moved across the high Arctic from Alaska to Greenland, in just a very few centuries around 4700–4500 years ago (McGhee 1998). Their origins are uncertain, but they carried tool assemblages and left behind sites that have affinities to those of the Siberian Neolithic. These were groups who exploited seasonally freezing coasts and especially the adjacent interior highlands of the Arctic. They traveled far, and fast, but left little behind: the sites are few, widely-spaced (implying vast stretches of ground were left unoccupied and unsettled), and sporadically occupied by what must have been small populations. How they pulled themselves through this territory is uncertain, given their lack of time to accumulate knowledge of its complex environments and resources. McGhee raises the tantalizing hypothesis that they exploited a keystone species — musk-ox — which had evolved the unfortunate defensive strategy of responding to threats of predation by bunching in a circle. This may have proven effective against wolves (their major predator until humans came onto the scene), but it would have enabled humans to come in for dangerously close shots.

The descendants of these groups ultimately disappear from archaeological sight, replaced on the landscape by the Thule (who *do* appear to be ancestral Eskimo). Like the Paleo-Eskimo, the Thule move quickly across the High Arctic, but much later (Dumond 1984; McGhee 1984). Around 900 A.D. they exploded out of western Alaska, moved eastward across the Arctic Coast, and arrived in Greenland within just a few centuries.

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Like the Paleo-Eskimo, they were tracking a keystone species, primarily bowhead whales, a species they'd hunted for millennia, mostly around the Bering and Beaufort Seas. There they may have stayed, save for a warming trend around this time that melted summer pack ice across the high Arctic, enabling bowhead whales to expand east through now-unfrozen seas. The Thule hunters went along for the ride, metaphorically speaking, leaving behind a tool kit remarkably similar from Alaska to Greenland (McGhee 1984:370–373).⁵

Yet, unlike the Paleo-Eskimo groups who had an easily exploited keystone prey in a relatively stable landscape, or the Thule, who were radiating outward in a familiar, homogeneous, and expanding niche, Clovis groups had no such advantages. They were pioneering a trackless, increasingly exotic, and highly diverse landscape. Not only did the landscape vary across space, it *varied through time*, as longstanding biotic communities dissolved, and plants and animals responded to the climatic changes that accompanied the end of the Ice Age. How those changes took place, and whether rapid enough to trigger drastic and unpredictable fluctuations in prey populations on a temporal scale (annual or decadal) that would have been detectable to and directly impacted human foragers, we cannot yet say.⁶ Keep in mind that human life spans are (even today) less than a century — during Clovis times they were undoubtedly shorter. Biological or ecological processes that played out over several centuries may not have dramatically impacted human foragers, though certainly groups at the latter end of those Late Pleistocene changes faced a different world than those who first came to the land.

Clovis groups also expanded across a much larger area than these Arctic groups — and just about everyone else we know of archaeologically. And unlike the landscape crossed by those fast-moving Arctic peoples, where the sparseness of resources made it advantageous to move quickly, Late Pleistocene North America was a very different place. Once groups were south of the ice sheets and beyond the range of near ice, periglacial conditions; they were in complex temperate and sometimes resource-rich habitats. The speed and frequency and distance that hunter-gatherers move daily, seasonally, or annually, is a function of many factors, not least of which is the spatial/temporal availability and abundance and distribution of critical resources (food, as well as water and stone), the density and return rates of preferred prey populations (and how quickly those changed under predation), the structure and relative richness and patchiness of the resources on the landscape, and so on. Unfortunately, we cannot measure these variables for the Late Pleistocene of North America; what we can say, however, is that this was decidedly not the high Arctic, and need not and may not have been a setting in which rapid movement was necessary or even advantageous.

A continent the size of North America, if colonized rapidly, must have stretched

Clovis populations very thinly across the landscape. There are *demographic* costs to moving that far that fast, for it almost certainly involved moving away from other people, whether kin or unrelated groups (MacDonald & Hewlett 1999; Meltzer 1995). There can be little doubt population density was lower at this time than at any subsequent point in American prehistory. And yet in the face of that, colonizers had to maintain a “critical mass” of population and an accessible source of potential mates — in order to avoid inbreeding or, worse, extinction. These demographic demands would have been more or less severe depending on the local group’s size, growth rates, age and sex composition, degree of environmental uncertainty (and the inverse: knowledge of the landscape’s resources), as well as how rapidly it was moving from its geographic homeland and/or other groups and the local environmental constraints on group size and population densities (Borgerhoff Mulder 1992:341–342; MacArthur & Wilson 1967:78, 80, 88; Meltzer 1999; Whallon 1989:434–435). On a diverse and unfamiliar landscape, the risk of extinctions is greatest soon after dispersal, when population numbers and growth rates tend to be low (Belovsky 1999).⁷

At the same time, groups moving into increasingly unfamiliar habitats had to *learn the landscape*, and identify and/or locate vital resources, since over the course of time in residence in an area the preferred or high-ranked resources in that area would decline due to foraging pressure. They had to learn what else would feed them, and what would clothe them, cure them, or kill them. They had to learn when and where and what other resources were available. Each new habitat colonizers entered would, for a time, have been *unpredictable* for the simple reason that the availability and abundance of plant and animal resources varies.

With fixed, permanent and predictable resources — like outcrops of stone suitable for making tools — landscape learning could be rapid. Learning about more ephemeral resources in unfamiliar settings — plants and animals — took longer, requiring as it did that resources be identified, and their properties or behaviors, habitat, location, short and long term patterns in abundance and distribution over time and space be learned, which in some cases might have required substantial observation or experimentation. Just how much of this behavior went on, no one knows, but bear in mind there are over 30,000 species and varieties of plants in North America *alone*. It would have been all but impossible for each new generation to sample anew their properties. Once observation and experimentation was complete, there must have been a considerable selective advantage to maintaining knowledge of a plant’s properties — as the similarity of medicinal plants across different areas attests (Daniel Moerman, personal communication, 1999). But still knowledge had to be gained anew, as groups moved progressively further south, and into areas with unfamiliar and exotic floras.⁸

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Would that suggest groups may have then initially focused on big game, as a class of prey that would have enabled easy crossing of ecological boundaries or into unknown territories (much as musk-ox possibly enabled groups to penetrate the high Arctic)? Perhaps, but keep in mind not all animals, let alone all elephants (mammoth and mastodon, in our North American Pleistocene case) are alike in their behavior. Foragers harvesting different and perhaps unfamiliar species in the same size class (large game, in this example), might have been able to bring generalized weaponry, hunting skills, and tactics to bear on all such prey (Kelly & Todd 1988:234), but how those different species may have responded would have varied considerably by species, as Frison has argued (1991). Even within a species, different animals may behave very differently across the landscape and at different times. Unless the environment is extraordinarily rich and animal encounter rates were very high, locating a specific prey species required knowledge of the *spatial and temporal and landscape behavior*, which varies by the animals' age, sex, group size and composition, the season, weather, time of day, competitive relationships, available water, physiological stage (breeding, pregnancy, lactation), species composition and heterogeneity of the vegetation, topography, and exposure to predation, among other factors (*e.g.*, Van Dyne *et al.* 1980:285–298; also Frison 1991:141; Johnson *et al.* 1992). All of which, of course, presupposes some knowledge of the landscape.

Obviously, one's knowledge of the environment and ability to predict resource availability and abundance increases with the time spent observing resources, and their cycles and patterns on the landscape. Colonizers new to a habitat haven't that knowledge base — and cannot ask the locals since there aren't any locals to ask — to successfully anticipate much beyond a seasonal or annual basis when and where resources would be available. Hence, patterns of hunting and gathering in an initial foray into a new landscape and habitat may have been more experimental and less systematic, more encounter-based and less intensive, than such patterns seen among groups after settling into an area.

In this regard, we see why the ethnographic record of hunter-gatherers is not an especially useful analogue for colonizers of empty continents. Virtually all the historically known hunter-gatherers have *neighbors*: Neighbors who are not only convenient sources of mates, but also handy sources of information about landscapes and resources (and who, in some cases, are also competitors, which can fundamentally alter the calculus of landscape use). Our models of hunter-gatherer foraging assume a forager has relatively complete information about resource distribution and yields, by which decisions can be made about how long to stay and when to leave a patch (Kaplan & Hill 1992:186; Kelly 1995:96–98; Stephens & Krebs 1986:75). They acquire the information by constantly monitoring the landscape and, because one group can only cover so much

ground, by talking to their neighbors and tapping their knowledge about resources available in other areas. Clearly, this was not an option for Clovis groups (or, for that matter, any new colonizers).

It has been argued, and I think correctly, that the greatest effort in information acquisition should occur in patchy and unpredictable environments (Kaplan & Hill 1992:186–187; also Kelly 1995:151, Stephens & Krebs 1986:103) — the very ecological situation in which Clovis groups initially found themselves. Indeed, there are reasons to think that on an unknown landscape, natural selection *would favor rapid and extensive exploration* to see what's over the next hill. Under the circumstances, one would *expect* rapid dispersal.

Demography and landscape learning are tightly linked, for several reasons, not least that the decision to stay in a patch or move onto the next is in part based on the suitability of a new patch relative to the current one, factoring in the costs of moving (Baker 1978:43). Those foragers who can better calculate those costs (by having more knowledge) will increase their odds of survival. By gaining information about a landscape one reduces mortality, and thus can increase population growth rates (MacArthur & Wilson 1967:88).

Arguably, then, the colonization process on a new landscape involved a trade-off between a series of competing demands, including: *maintaining resource returns*, or keeping food on the table, particularly as preferred or high-ranked resources declined, and in the face of limited knowledge of the landscape; *minimizing group size*, in order to buffer environmental uncertainty or risk on an unknown landscape; *maximizing mobility*, in order to learn as much as possible, as quickly as possible about the landscape and its resources (in order to reduce environmental uncertainty in space and time), while; *staying as long as possible in resource-rich habitats*, in order to enhance knowledge of specific changes in resource abundance and distribution (you learn more by staying longer); and, finally and perhaps most critically, *maintaining contact between dispersed groups*, in order to sustain information flow, social relations and, most especially, demographic viability.

Under the circumstances, we expect to see among colonizers *large scale exploration*, in order to map the landscape; periodic *aggregations* of widely dispersed groups in order to exchange mates, resources, and information; and *extensive mating networks*, in which spouses can be drawn from distant groups. And central to making all this work are two processes that might actually be detectable archaeologically: *high settlement mobility* to maintain contacts with distant groups, and monitor resources and environmental conditions beyond the social and geographic boundaries of the local group; and *open social networks*, which enabled individuals to move easily between and be readily integrated within distant groups (see the insightful paper by Anderson [1995] on this matter; Lourandos

[1997] outlines how these processes may have been manifest in Australia). Under the circumstances, strongly territorial behavior would be decidedly disadvantageous.

Disproving the Case

Now this is all well and good in theoretical terms, but how do we detect these social processes, archaeologically? Not easily, and with *very* broad brush strokes — as the data are not up to the resolution demanded of the models! But let me explore what we might see of landscape learning, mobility, and the opening and closing of social networks among Clovis and subsequent Paleoindians.

It has long been known that Paleoindians generally, and Clovis groups in particular, preferred high quality stone to manufacture their artifacts (Goodyear 1979; Haynes 1982). That stone can often be pinpointed to its geological source. As very little of it appears to have been acquired via trade or exchange with other groups (Meltzer 1989), the distances between the geological source and the site where it was discarded becomes an odometer of Paleoindian mobility. Oftentimes, the distances traveled were substantial: Among western Clovis groups there are several instances of stone procured upwards of 500 km from the site in which it was discarded. *Average* values of 300 km are not uncommon (Haynes 1982:392). Probably these groups were even more mobile than the figures indicate, for these values only record the straight-line distance from source to site, and take no account of side excursions, return trips, or other archaeologically invisible travel (Meltzer 1993a). Actual Clovis mileage may vary.

As Clovis groups looped around the landscape, they strayed far from their favored stone quarries, and as their artifacts were used, broken, and their stone supply dwindled, they carefully maintained, resharpened, and recycled their remaining tools. It's the sort of thing you expect of wide-ranging and highly mobile colonizers who might be exploring a new landscape or cannot anticipate what stone resources will be locally available. But then that same reliance on distant or exotic high quality stone is also evident among later Paleoindians, like Folsom and Plainview groups on the western Plains, who presumably had more knowledge of the land (in the eastern woodlands, later Paleoindian groups more quickly take up the use of local stone, a difference between east and west that may speak to important differences in land use patterns, demographics, and resource richness). So the pattern of relying on exotics obviously says more to stone preferences of mobile hunter-gatherers, than it does about the landscape familiarity of colonizers.

Let's delve a little deeper. One of the characteristics of the Clovis archaeological record that has become apparent lately is the unusual number of artifact *caches*. These contain anywhere from a dozen to a hundred or more pieces, flaked into shapes (bifaces,

blades) that are relatively easy to carry, and once needed could readily be flaked into any one of a variety of useable tools as the circumstances required. The caches rarely occur at Clovis camps or kills, but instead turn up in otherwise isolated spots, giving the appearance of having been stashed — presumably with the intent of being retrieved later. The caches are generally comprised of stone from rock outcrops often several hundred kilometers distant.

On its face, an artifact cache represents a handy solution to a logistical problem: The disparity between the location where a stone could be acquired (which is predictable), and where it was to be used (which is not always predictable, and in any case may be far away). By caching stone around the landscape, you make re-supply available without a long return trip to the quarry. We now know of at least a dozen or so Clovis caches, scattered throughout North America — but mostly in the west (Collins 1999). Given that later Paleoindian groups are just as mobile as Clovis groups, and just as reliant on high-quality distant stone sources, we would also expect to see caches from later Paleoindian periods. Yet, we don't: Later Paleoindian caches are extremely rare.⁹

There are now enough Clovis caches, and few enough later Paleoindian ones, to suggest the pattern is real and not a sampling effect. How then, can we explain it? The scarcity (if not absence) of later caches is attributed by Michael Collins (1999, and personal communication) to the *predictability* of Clovis movement: He suggests these groups knew in advance where they were headed, knew they would be returning to particular spots with exhausted tools in need of replenishment, and hence left stone cached behind for future use. Later Paleoindians, he argues, could not predict their future movements with enough confidence to benefit from caching stone.

Perhaps. Yet, the stone used in Folsom times (immediately post-Clovis) comes from a greater diversity of sources, sometimes from greater distances (Meltzer, unpublished data). This more complex pattern of stone acquisition, suggests that however unpredictable their future movements, they certainly knew where the sources were and were highly adept at planning their use. Moreover, if Clovis groups knew they were returning and would need and use the stone, then why were the caches still there 11,000 years later? In fact, I tend to suspect the opposite was occurring: That Clovis groups were so *new* to the landscape they didn't know and could not predict where or when they were next going to find vital resources. By leaving caches scattered about the landscape, as they moved away from known sources, they created artificial resupply depots, and thus anticipated and compensated for their lack of knowledge. If they found no stone in the area where they were headed, they at least would not have to double back completely to the outcrop to refurbish their tool kits when those were used up.

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Stone is especially suitable for caching, since unlike meat or other foods, it won't spoil, won't be attractive to scavengers, and barring tectonic activity, won't move before you return. A stone cache becomes a fixed and predictable and essentially permanent location. As such, it serves a useful role in exploring and learning new lands, for now the emerging map of the landscape includes not just the newly located natural resources, but also some artificially-placed ones. This helps make it possible to venture further and more widely across otherwise unknown and unpredictable terrain. Over time, as new sources of suitable stone are located, and as groups are better able to predict where and when they will be able to replenish their supplies (presumably in the post-Clovis period), then caches become less critical to movement, and ultimately unnecessary.

Of course, one cannot use the *absence* of caches in later Paleoindian periods as proof that landscape learning is complete by then — at least not without getting dizzy traveling in a logical circle. But I think there might be independent evidence — albeit circumstantial — to indicate that might be the case, evidence which gets us back to the issue of changing social networks.

Colonizers on a landscape not only had to be able to track great distances to find mates and exchange information and resources, they also had to be able to get along with those near and distantly related groups they encountered. Having large and open social networks based on flexible and fluid social and kin relations, fewer languages, the easy integration of individuals and groups, and sometimes long-distance exchange and alliance networks — all combine to diminish differences among peoples who need to stick together under geographic circumstances that might otherwise keep them widely separated for years at a time (Anderson 1995; Meltzer 1998).

One way these open social systems are manifest in the material and archaeologically visible realm, is by the widespread distribution, use, and exchange of recognizable, and sometimes highly symbolic, artifact forms. These forms had social and ritual functions, and over long spans and large areas served to maintain recognition and alliances. In a similar situation but a very different setting, Kirch argues that the exchange of Lapita ceramics and other items between the widely separated island populations of Oceania served as a social binding that helped insure long-distance alliances and a supply of suitable marriage partners in the face of “unpredictable environmental hazards . . . [and] demographically small and unstable groups.” It might have meant the difference between survival and extinction on these remote islands (Kirch 1988:113–114, 1997:254).

Which brings us back to Clovis points. Early in the Paleoindian period, these artifacts are more broadly similar (stylistically, technologically, and typologically) across a larger area of North America, than any artifact forms in any later cultural period, Paleoindian or otherwise (Figure 2).¹⁰ In fact, around the world the only other artifact forms com-



FIGURE 2. Generalized distribution of Clovis and related fluted points, ~11,000 yr B.P. (only Plains and southwest sites are radiocarbon-dated to this age). (See endnote 11 for explanatory comments).

parable in distribution are Lapita ceramics across the islands of Oceania, and the so-called “Venus” figurines of Upper Paleolithic Europe and Eurasia (Whallon 1989). The *extent* of the Clovis distribution is a by-product of the size of the colonizing footprint, but the *similarity* across that range may well reflect some measure of the *social* network on the landscape, the symbolic value of that network, such similar forms provide, as well as perhaps some measure (or by product) of a cultural founder’s effect.

Whatever the precise cause, the conditions behind it ultimately changed, and did so within a matter of centuries. Although the timing varies by area of the country, sometime after 10,900 years ago in the central and western portions of the continent, and after 10,600 years ago in eastern North America, Clovis and its related and highly similar forms disappear (Figure 3). By 10,600 years ago, there are in place across North America a variety of regionally-distinctive point forms (Anderson & Faught 2000).

Unlike Clovis, these later Paleoindian points are more restricted in their geographic distributions. At least in some areas, these more-regionally specific forms correspond

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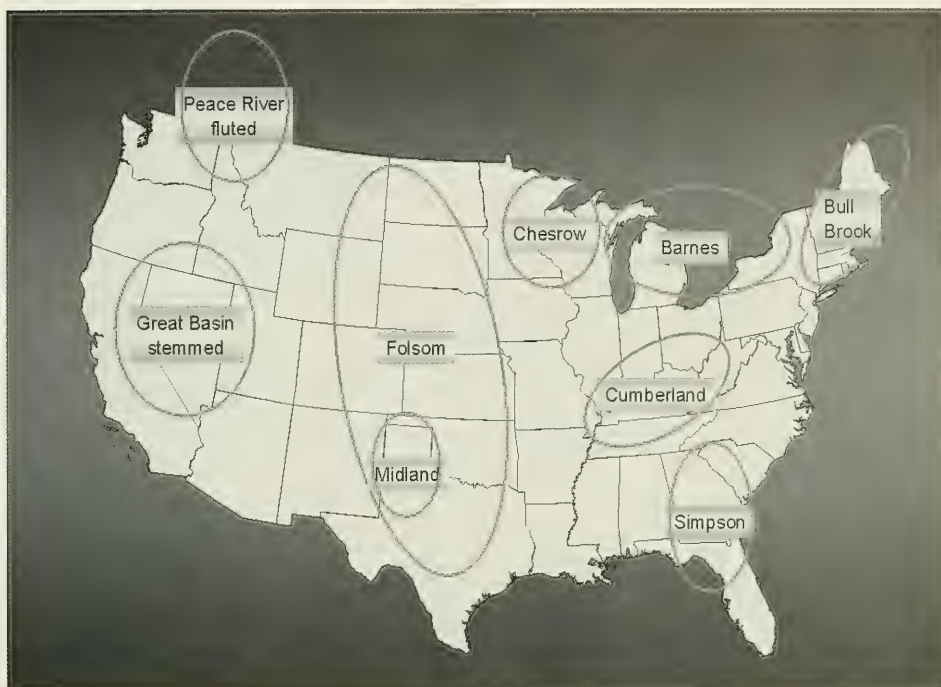


FIGURE 3. Generalized distribution of select Paleoindian point forms after ~10,900 (in western North America) and ~10,600 yr B.P. (in eastern North America).

with the development of distinctive adaptive strategies. The best known and most readily recognizable of these is the Folsom complex, which appears on the Plains and in the Rocky Mountains of western North America, with a subsistence strategy tightly tied to exploitation of the now-extinct species, *Bison antiquus*. In other areas, the adaptations of these groups is different and less well known.

That process of shrinking style zones continues, and by 10,000 years ago most areas of North America have very distinctive point forms (Figure 4), and perhaps adaptations as well. For it is in this window of time that we see the development of new technologies (e.g., the Dalton adze in the Midwest), new and sometime prey- or region-specific strategies for hunting and processing, and increasing reliance on more locally available stone for artifact manufacture (see, for example, the papers in Anderson & Sassaman 1996).

Let's assume that these stylistic forms and traditions mark cultural groups or lineages (however those terms are defined), and that different stylistic forms mark changes in



FIGURE 4. Generalized distribution of select Paleoindian point forms after ~10,500 B.P.

those cultural groups or lineages. Considered that way, the shift from broad and overall homogeneity in stylistic forms, to narrower and more regional ones, in the span from 11,500 to 10,500 years ago, can be seen as the settling in of colonizers into specific areas and/or habitats; a reduction in the scale or openness of the social systems; and the development of more region-specific adaptations (also Anderson 1995:5, 11).¹¹ I wish I could say more about this issue, but I don't think I can at the moment without abusing the archaeological record even more than it has been.

Conclusions and Some Implications

So why did Clovis groups radiate so far and so fast — assuming they did? I don't think it was because they were chasing mammoths — or because they were being chased by mammoths — or because the extinctions of these animals left Clovis groups with little to eat, so they had to press on. Rather, I think it is because they found themselves on

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a vast and empty landscape that was unknown and unpredictable, in which there was a selective advantage to widespread movement. During the critical early centuries of their dispersal, they still maintained vital long-distance links to other groups that could provide mates, resources, and information. As their knowledge of the landscape and its resources became ever-more detailed, their foraging systems became more stable. This, in turn, increased their population size, lessened their odds of going extinct, and enabled them to extend their overall settlement range, and venture further from one another. In the end, Clovis and related groups were, with little doubt, highly successful colonizers. Within a thousand years, much of the North American continent was populated with their descendants.

But who were their *ancestors*? We're not altogether sure. As noted above, there are no obvious Clovis progenitors in Beringia (but see Goebel *et al.* 1991; Hoffecker *et al.* 1993). Certainly, the most diagnostic aspect of Clovis — its fluting technology — looks to be uniquely American. While some fluted points have been found in Alaska, they are mostly undated, and may be *younger* than those further south (Reanier 1995). Still, most archaeologists look to Alaska and northeast Asia as the ultimate source area for the Clovis population. Whether they arrived, as the traditional notion has it, fast on the opening of the ice free corridor is uncertain, given the uncertainty of our knowledge of the timing of that opening (Jackson & Duk-Rodin 1996; Mandryk *et al.* 2001).

Some, in fact, suggest they made their way into the continent — or at least parts of the continent — sometime earlier. They point to Meadowcroft Rockshelter in Pennsylvania, which has produced a lanceolate point with a pre-Clovis age of 12,800 years ago (Adovasio *et al.* 1990), and (of late), to Cactus Hill, Virginia, which has produced Clovis points and, below them, decidedly non-Clovis forms in sand dune deposits dated to upwards of 16,000 yr B.P. (McAvoy *et al.* 2000). Neither site is fully accepted by the still-skeptical archaeological community.¹² Still, there's something curious about eastern North America: There are more *Clovis* artifacts from here than any other area of North America, implying a relatively longer period of occupation — though whether it began earlier or lasted later we cannot say (Anderson 1990; Mason 1962; Meltzer 1988). Meadowcroft, Cactus Hill, and the great abundance of Clovis in eastern North America have led some to suggest that Clovis was invented here, and from whence it rapidly spread west.

But then there's been an even more radical spin to the notion, for it has not gone unnoticed that having Clovis radiate out of eastern North America puts it that much closer to Europe. And Europe is where Stanford and Bradley (this volume) ultimately see Clovis origins (also Boldurian & Cotter 1999). Their argument, briefly, is that there are such strong similarities in technology and artifacts of the Solutrean Period of Upper

Paleolithic Europe, and those of Clovis, that one must be descended from the other. Those similarities include: distinctive biface thinning technologies (particularly the use of *oultre passé* thinning), common end scraper forms, the presence of bone rods and engraved stones, a reliance on exotic raw material, and the use of red ochre. As they envision it, Solutrean maritime hunters carrying these technologies and artifacts left the Iberian Peninsula in skin canoes heading north and west. They hunted their way through the leads fronting the pack ice that had descended across the Pleistocene North Atlantic, and ultimately made landfall in eastern North America, from whence sprang Clovis.

This is a fairly provocative claim (Sellet 1998). Recognizing its controversial status, Stanford asks us to “suspend disbelief” while he and Bradley work out the details. While I’m not willing to suspend my disbelief, I am — in the spirit of Davis’s (1926) notion of an “outrageous hypothesis” — willing to concede our knowledge of Clovis origins is limited, and it is worth examining our evidence and arguments closely about what we know and do not know on the matter, and how much latitude there may be within the current evidence for such alternative hypotheses. So I think it only fair they be granted the opportunity to work out the details, as proving their case will take time and will be no easy matter, as they appreciate.¹³

Still, there are obstacles to this hypothesis, the most substantial of which surfaced the very first time American archaeologists sought to connect the prehistories of America and Europe. Over a hundred years ago, archaeologists filled museum cases with stone tools from New Jersey and Ohio and Washington, D.C., which, because they looked like and appeared to have been made in a similar way to European Paleolithic handaxes, were argued to be the same age and historically related (Abbott 1889; Wright 1892; summarized in Meltzer 1991). Thus, the American Paleolithic was born, and scholars crafted scenarios for moving Stone Age Europeans across the Atlantic (where, in the understanding of the times, they were considered ancestors of the modern “Esquimaux”). Yet, the American Paleolithic proved short-lived: Critics pointed out the similarities between the two continents’ artifacts were so general as to have little meaning (Holmes 1892): these were different *kinds* of artifacts, with different functions (the American forms being merely rejected unfinished artifacts, while those from Europe were finished tools). Any similarities between them, it was argued, could have easily resulted independently, a *convergence* in the way in which the artifacts were made, or perhaps nothing more than random chance.

The idea of a direct European ancestry for the first Americans disappeared quietly by the turn of the century, resurfaced briefly in the 1960s (*e.g.*, Greenman 1963), and is now once again in play. In its current presentation, the details have obviously changed (we know a great deal more about the prehistories of both continents), but arguably the

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structure of the linking argument has not: It is still based on identifying a number of presumed similarities in the artifact assemblages and technologies across the ocean. Yet, Solutrean and Clovis assemblages are really very different — in form, technologies, and materials — as Solutrean expert Lawrence Straus and others have argued (Straus 2000; also Sellet 1998). Most obviously, Solutrean points lack the fluting diagnostic of Clovis, and their assemblages include stone artifacts and bone tools never found on these shores (Sellet 1998; Straus 2000). Where there are similarities, we cannot eliminate the possibility of *convergence*. After all, red ochre has been used throughout prehistory wherever it occurs, for there are few other natural paints so easy to use, and none so richly symbolic as this blood-red mineral. For that matter, using high-quality exotic raw materials is characteristic of many highly mobile groups, not just Solutrean and Clovis (see, for example, Soffer 1985).

Even if the similarities were more pronounced and less superficial, we still face the very formidable problem that the Solutrean and Clovis cultures are not only separated by thousands of miles of space (most of which is ocean), they are also separated by roughly 5000 years in time: Solutrean ended ~16,500 years ago, while the *earliest* Clovis site (the Aubrey site, in Texas [Ferring 1994]) is only 11,500 years old.¹⁴ The purported pre-Clovis age sites might bring us closer to Solutrean times, but the known or suspected pre-Clovis lithic assemblages — like those at Cactus Hill or Meadowcroft, for example — are even less like Solutrean than Clovis assemblages. And while negative evidence tends not to last in archaeology, it is appropriate to add that there is no evidence Solutrean groups had boats, a maritime adaptation, or were living far enough to the north in Europe to put them in a geographic position to skirt the pack ice of the North Atlantic (Straus 2000). For that matter, no Solutrean points have ever been found in North America, let alone in New England where one might expect initial landfall (and it pushes the bounds of credulity to suggest that any or all Solutrean points brought to America were lost on the now-submerged Pleistocene coast). I leave it to others in this volume to comment on the genetic, linguistic, and dental evidence that addresses the origins of Native American populations (see, for example, the papers in this volume by Merriwether, Nichols, and Turner).

At the moment, then, the archaeological evidence by itself provides no support for the idea that ancestral Clovis groups originate in Upper Paleolithic Europe. Now, all of this might represent a minor skirmish safely confined to archaeology, were it not for the fact that the last several years have also seen a number of human skeletal forms appear in the New World which were labeled (at least initially), as “Caucasoid,” with the strong implication they represent a migratory pulse from Europe to America. It is now apparent the most famous (or infamous) of those forms, the Kennewick skeleton, is not

“Caucasoid” at all, but an ancestral Native American with affinities to Asian populations (Powell & Rose 1999; also Chatters 2000).

Yet, if Kennewick is not a “Caucasoid,” and Solutrean seafarers were not in America, why do we have individuals that look apparently so unlike contemporary Native American peoples — so much so that we take them to represent non-Asian populations?¹⁵ Let me tie the question back to the earlier discussion of colonization, for viewing the Clovis radiation as I have suggested it might be viewed archaeologically has some interesting implications for our understanding of their biology, as well.

Recall that colonization in its early stages demanded the maintenance of long distance linkages to insure a sufficient breeding pool. Yet, once the descendant groups had begun to settle into different areas and develop their own adaptations and historical trajectories, the very vastness of the North American continent and its topographic and geographic barriers (glacial ice, major river systems, mountains), conspired to impede interaction. In the millennia following Clovis we no longer see archaeological evidence for far-reaching linkages across North America, and I think we can assume there wasn’t much *biological* interaction or gene flow across this vast range either. Evidently, the local populations were relatively isolated, and even though continent-wide population density was low, it was still sufficiently large that isolated groups were no longer in demographic danger, and hence did not have to maintain long-distance mating patterns.

Obviously, there would be genetic and phenotypic consequences of the reproductive isolation of these groups, as the spatial scale of the effective gene pool shrank. If, as my colleague geneticist Mike Hammer has suggested (personal communication), there were local founder effects accompanying this post-Clovis divergence, and if these groups were reproductively isolated for relatively long periods of time, then it’s really no surprise why apparently anomalous human skeletons like Kennewick look anomalous, and unlike modern Native Americans.

Of course, following nine thousand years of population growth and evolution among North American peoples, and the re-establishment of gene flow among distant groups (and thus an expansion of the effective gene pool), it’s not surprising that a distinctive Native American form will evolve, and that it would be unlike Kennewick or some other ostensibly “anomalous” skeletal forms. But that doesn’t mean the various forms are unrelated, or that we have to look anywhere besides far northeast Asia for an ancestor of these early individuals or, for that matter, of their archaeological culture.

So where *do* we go from here? We must continue to explore in the theoretical realm, with testing against the hard anvil of the empirical record, our ideas about range expansion across new lands. Can we determine *approximate* population growth rates of colonizing populations? What are the factors that will control those rates, and will they vary

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across the colonizing space, and through time? What social mechanisms (besides those noted above), may have been in place for maintaining long-distance relations and demographic viability among colonizers, and did those mechanisms change depending on the structure of the environment (*e.g.*, tropical forest versus temperate grassland)? If large social networks were in place, what were the effects on language, genes, and material culture, and are those reflected in descendant populations? (This raises the questions of whether and how we might ultimately reconcile data from linguistics, genetics, and archaeology).

We need to investigate how rapidly hunter-gatherer groups could (did) map onto an empty and unknown landscape. How fast does resource knowledge accumulate, and is the scale in years, generations, or something beyond? To what degree is this learning process driven (or otherwise influenced) by population dynamics (population numbers and density) and social mechanisms (including degree of dispersion or nucleation of groups)? At what temporal scale (beyond the life span of an individual) can human groups effectively monitor and store information about environments, environmental change, and adaptive responses? If information storage is on the scale of several generations (*e.g.*, upwards of a century), what consequences will this have for the scale of adaptation? Will it shift from shorter-term, small resource fluctuations to longer-term, larger resource cycles (Whallon 1989:443–444)? And how can this be modeled or seen archaeologically in a colonizing population?

We must better understand how rapid climatic and environmental changes were at the end of the Pleistocene, and whether these would have been detectable on a human scale. If the climatic and ecological changes of the Late Pleistocene were detectable to human foragers, what impact, if any, did these have on the tempo and spatial patterning of colonization? What may have speeded or slowed movement through particular environmental zones?

A more basic issue: We must determine whether the spatial and temporal resolution of the archaeological record and our chronological methods are sufficient to see whether the colonization process moved in a geographically patterned way across the continent, and whether that process was driven by climatic or environmental change. Is the temporal resolution of the archaeological and paleoenvironmental records and our chronological methods sufficient to the task? Can we differentiate a colonization process that was gradual, from one of relatively long periods of stasis within habitats, interspersed with rapid movement between habitats? Or do these happen in the “wink of a radiocarbon eye,” and would not be detectable twelve thousand years later?

Some thought must be devoted to what we are looking at when we are looking at artifact forms (see endnote 10). Are there changes in artifacts and material culture that can

help us track the flow of and see the adaptive changes taking place within colonizing populations across space and through time? Are these units of material culture always (ever?) isomorphic with social or linguistic units (let alone genetic ones?). Just what do they mean in terms of adaptation, social networks, and territoriality?

Finally, let's not forget the perennial questions: Where in Asia did these first Americans come from, and why have their traces so far eluded us, and what does that tell us about our search strategies or — possibly — our ability to tease out historical affinities from artifacts? Just how early we might be able to push back their entry into the New World? Did they come by land or by sea, or both — when? how? and how often? Why is there so little evidence of their pre-Clovis presence in North America, and what does that say about the archaeological record, or of our techniques for site discovery?

These are interesting times in the study of the peopling of the Americas. Much of what we knew, or thought we knew, has been turned on its head in the last few years. In the scramble to right ourselves many ideas — some controversial, others outlandish — are being tried on for size. Even in this paper. It's a natural course of events in scientific change, and no cause for alarm. Yet. There is still much to learn.

Abstract

While much attention has been focused on when the first Americans arrived, an equally interesting (and perhaps equally controversial) question pertains to how they colonized the continent. Leaving aside the compelling evidence from South America of an early entry into the New World (Dillehay's Monte Verde work), it remains the case that in North America the earliest accepted evidence is of Clovis remains (~11,500 years old). And that evidence points to a radiation across the length and breadth of North America in an astonishingly brief time. If Clovis groups were the first highly successful colonizers of North America, and if no one else was home when they arrived (and there are caveats to accepting both these notions), then how is it they moved so far and so fast over what became an increasingly exotic and unfamiliar New World? How did they map onto new resources, cope with novel pathogens and diseases, and locate and replenish vital supplies of high-quality stone and water? And, how effectively they were able to maintain their population size and reproductive viability while spread thinly on the landscape? We have plenty of answers to these questions. Unfortunately, we cannot figure out which of the answers are right. But we can at the very least explore some of the critical issues related to colonizing empty continents.

Acknowledgments

I would like to thank my old graduate school friend and Tom Robbins' heroine, Dr. Nina Jablonski, for the opportunity to participate in the Wattis Symposium; Nancy Gee for so ably handling the logistics of the visit; and, of course, Mrs. Phyllis Wattis for making it all possible. My thinking on the issues raised here have benefited from conversations with and comments from Drs. James Adovasio, Lewis R. Binford, Michael B. Collins, Donald K. Grayson, Michael Hammer, Daniel Moerman, and Lawrence G. Straus. This paper was reviewed by several individuals, at least two of whom (Drs. David Anderson and Stuart Fiedel) identified themselves. I thank all for their comments and suggestions, only some of which could be incorporated here. Which means I'm on my own, blame-wise, for this one.

Endnotes

¹ In preparing my paper for this volume, I had the (self-imposed) choice of either leaving it in the conversational form in which it was prepared for the original oral presentation, or extensively re-writing it to make it more staid and scholarly. Unable to overcome my own slothfulness, I opted for the former, and did little more than add a few sections and footnotes here and there, and insert some appropriate references. This paper is not intended to be an exhaustive review of the literature. My apologies in advance to any colleagues who see this as a breach of scholarly decorum.

² All ages given in this paper are in radiocarbon years before present ("present" by convention being defined as 1950). While techniques are now available for calibrating radiocarbon ages on a calendrical scale, I will not do so, for several reasons: First, the calibrations for this period of the Late Pleistocene are still very much in flux. Second, keeping the ages in radiocarbon years before present makes them comparable and compatible with the vast majority of the literature that interested readers may choose to pursue. Finally, I am only speaking of ages in general, so calibration would be superfluous.

³ Let me stress that this does *not* contradict the possibility initial peopling of North America took place in pre-Clovis times: Monte Verde could testify to a colonizing pulse that moved down the Pacific coast of North America without turning inland, effectively leaving no archaeological footprints on this continent (but see Surovell 2000a). Or, Clovis might be derived from a pre-Clovis presence that had only worked its way into a corner of the continent — say, eastern North America (as suggested by Mason 1962; also, Meltzer 1988). Finally, it could represent, as the traditional notion has it, an immediate rapid postglacial arrival down the newly-opened ice-free corridor. Regardless, the

tight radiocarbon ages on Clovis, and the vast range it covered, speaks of a rapid and unhindered radiation.

⁴ We have an ocean-going analogy: Once groups in Near Oceania (New Guinea, Bismarck Archipelago, Solomon Islands) developed the technology and knowledge to navigate vast stretches of empty ocean, say ~3500 yr B.P., they moved with surprising speed across the distant islands of the Pacific (Irwin 1992; Kirch 1997). While there is much to be learned from comparing such cases, this radiation differed in many fundamental respects from that of hunter-gatherers traversing new continents. As the question inevitably arises, I should also add that this Pacific expansion has nothing to do with the original peopling of the Americas. These Pacific peoples do not appear remotely close to South America until well after that continent was occupied. I remain profoundly skeptical that there were any earlier contacts across the ocean; for that matter, I do not see any significant contact between peoples of the Pacific and those of the America in pre-historic times.

⁵ The Thule case is of interest as a Clovis analogy for another reason: By the time they reached central and eastern Canada, they were coming into territory previously inhabited by at least one branch of descendants of those Paleo-Eskimo groups. How the populations interacted is not known, but is of considerable interest.

⁶ We do know from Greenland ice cores and ocean sediments that climatic change can be rapid and significant — with atmospheric temperature changes of as much as 20° – 25°C in less than 50 years in terminal Pleistocene and Younger Dryas times over the Greenland ice sheet, for example (Alley 2000; White 2000). But how that change was manifest over continents in terrestrial climates, plant, and animal communities is not known. While there is evidence that change can be rapid in short-lived, temperature sensitive, lake-dwelling microorganisms (*e.g.*, Birks & Ammann 2000), one should not generalize those patterns to the kinds of plants and small and large game resources exploited by humans.

⁷ In a paper that appeared after this was written, Surovell (2000b) provided a model which showed that by using certain strategies for moving about the landscapes, hunter/gatherer groups can travel great distances rapidly, yet still maintain high fertility and population growth rates, and do so without suffering demographic consequences. The model is elegant and downright intriguing, but whether it is applicable to the Clovis situation will require construction of a far better bridge between it and the data than we now possess.

⁸ Moerman (personal communication, 1999) makes the important observation, however, that in folk taxonomies plants are more often identified at the genus, rather than the species, level. For highly mobile peoples, it is more adaptive to be able to recognize

generic plants, than particular species which may have much more restricted distributions.

⁹ Caches will appear at other times and places much later in prehistory, but under conditions far different from, and presumably for different reasons than, Paleoindian caches.

¹⁰ The circles and ovals on this and subsequent distribution maps are intentionally highly generalized: What I wish to convey are very broad spatial patterns, not specific point distributions. Let me explain why. First, the data do not exist to provide, at the continental scale, anything approximating a detailed distributional map (though Anderson *et al.* [2000] are making important headway in that direction). Second, as Jack Hofman (1992) and others (*e.g.*, LeTourneau 1998; O'Brien & Lyman 2000) have rightly argued, there is considerable variability — spatial, temporal, stylistic, technological, etc. — in these point forms. Unfortunately, that variability is not fully appreciated or understood or incorporated in our analytical classifications (Anderson 1995:20). Drawing boundaries (be they classificatory or cartographic) around point forms is an arbitrary exercise in any case. Thus, rather than give the false impression, by highly detailed maps, that we have captured a set of well-defined and distinctive forms in time/space, I simply drew circles and ovals around modal tendencies, with the explicit caveat that these are, at best, circles and ovals around modal tendencies: no more, and no less. Without question, there is overlap among the forms, and occurrences outside the boundaries show. All of which highlights the value of gaining better control on the many dimensions of variability of these point forms, for when such data are ultimately available, it will provide important insights into Paleoindian artifact variability, distribution, and so on.

¹¹ This settling in process might also be manifest in the well-documented and apparently abrupt increase in the use of cave and rockshelter sites in eastern North America in Late Paleoindian period — there being a singular lack of such use in Clovis times (Walthall 1998). It was later Paleoindian groups who, having mapped their landscape, found those locations, shifted their adaptations toward more local resources, and became more territorial, could use such fixed and permanent locales as important components of their settlement strategy. Perhaps. But one must always be wary in archaeology of placing too much weight on negative data: It often doesn't last. It may only reflect methodological shortcomings: Have we dug such sites in the right way and thoroughly tested for Clovis age components? Collins (1991) gives compelling reasons to think not; and even if true, is it necessarily significant?

¹² Meadowcroft has cheated archaeology's actuarial tables (Meltzer 1993), and remains a viable pre-Clovis candidate long after its initial appearance on the scene. Lately, one of the key objections to the site's antiquity — that the radiocarbon ages were cont-

aminated by groundwater seeping through the lower deposits on site — was effectively rebutted by micromorphological analyses of the sediments (Goldberg & Arpin 1999). Cactus Hill has been more recently reported. There is little question but that Cactus Hill has yielded distinctive artifacts in strata below a Clovis level. That this assemblage bears more than a passing resemblance to the early material from Meadowcroft makes it all the more intriguing. However, there is uncertainty about the *absolute* age of those pre-Clovis materials. Certainly they appear pre-Clovis in a relative sense (below Clovis), but how much earlier in absolute time seems an open question, given the range (from Pleistocene to modern) of radiocarbon ages from that level. It remains to be seen how “pre” the pre-Clovis at Cactus Hill will turn out to be.

¹³ It is with some reluctance that I even raise these issues here, but do so for two reasons. First, the idea of a Late Pleistocene trans-Atlantic crossing has already gotten considerable media play, and too often (the media being the media) it has been presented as highly likely, without any consideration of the possible obstacles to such a hypothesis. Those need to be raised, to put the discussion in a larger context. Second, at the panel discussion at the end of our Wattis symposium, I was directly asked to speak to this issue, in light of my comments on Clovis. This is the long-delayed answer to that question.

¹⁴ As there appears to be some confusion on the matter, let me state here that the Aubrey site does indeed have an unequivocal Clovis fluted point.

¹⁵ I would also ask this: Should we necessarily expect skeletal forms of this antiquity to look like modern Native Americans, even if they are Native American ancestors? Perhaps not. Over 9000 years separate these early forms and modern Native Americans. One can imagine a fair amount of evolutionary change in the relatively plastic morphological attributes of the skull over that time.

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CHAPTER FOUR

ANATOMICALLY MODERN HUMANS, MARITIME VOYAGING, AND THE PLEISTOCENE COLONIZATION OF THE AMERICAS

Jon M. Erlandson



During most of human history, water must have been a major physical and psychological barrier and the inability to cope with water is shown in the archaeological record by the absence of remains of fish, shellfish, or any object that required going deeply into water or using boats. There is no evidence that resources of river and sea were utilized until this late pre-agricultural period . . . for early man, water was a barrier and a danger, not a resource (Washburn & Lancaster 1968:294).

For decades, most anthropologists have believed that maritime adaptations and seafaring developed very late in human history and that the Americas were first colonized by terrestrial hunters who walked through the interior regions of Beringia and the Americas. Since the 1970s, perceptions about the antiquity of human seafaring have changed dramatically, but theories about the development of maritime adaptations and the peopling of the New World have not kept pace. Recently, there has been a veritable sea change in our perceptions of the Pleistocene colonization of the Americas. Just a few years ago, there was a general consensus that the New World was colonized sometime in the very Late Pleistocene by land-based hunters who trekked across Beringia and down the fabled ice-free corridor into the heartland of America, gradually spreading from sea to shining sea. An alternative theory, long peripheral to the dominant paradigm, proposed that maritime peoples followed the coastlines of the North Pacific from Asia to the Americas — moving by land and by sea from northeast Asia, along the southern shores of Beringia, and down the Pacific Coast of North America. Ironically, while this “coastal migration theory” has gained adherents in recent years, it has become almost conservative compared to scholarly claims and media accounts that the Americas may have first been colonized by seafaring Australian Aborigines, Polynesians, or even

Europeans who crossed the open Pacific or Atlantic oceans by boat (*e.g.*, Dixon 1993; Cann 1994:10; Locke 1999:16; Toyne 1999; Stanford, this volume).

After roughly a century of scientific investigation into how and when the Americas were first settled, many scholars and lay people might reasonably ask how we got from “Clovis-first” to the “Coastal Migration Theory” to “Almost Anything Goes” in such a short amount of time? The answer to that question is complex, but an important component of it clearly grows out of the emerging (but not unanimous) consensus that the so-called “Clovis barrier” has been broken by the 12,500 year old pericoastal site of Monte Verde in Chile (see Dillehay 1997; Meltzer *et al.* 1997). Also contributing is an emerging body of data that suggests that the ice-free corridor developed relatively late in time and was probably a daunting and difficult landscape for hunter-gatherers to survive in (*e.g.*, MacDonald 1987; Clague *et al.* 1989; Mandryk 1991; Wright 1991; Elias, this volume). Research has also shown that the coastlines of Alaska and British Columbia deglaciated earlier than once thought and were more suitable for human occupation than previously believed (*i.e.*, Mann 1986; Molnia 1986; Barrie *et al.* 1993; Heaton & Grady 1993; Mann & Peteet 1994; Mann & Hamilton 1995; Dixon *et al.* 1997; Josenhans *et al.* 1997). As these issues are discussed elsewhere, they are not the focus of my paper. My colleagues in this volume also summarize the genetic, biological, and linguistic evidence for the peopling of the New World.

Instead, I focus on another prime reason why the idea that Pleistocene coastal migrations into the Americas may have occurred has been marginalized for decades. This is the fact that we have long underestimated the sophistication of our distant ancestors, the importance of the sea in human history, and the maritime capabilities of Late Pleistocene peoples. When did our ancestors first develop relatively complex technologies? When did they adapt to the sea and first use relatively sophisticated watercraft? When were the Americas first settled and what do current archaeological data tell us about the possibility that maritime peoples may have followed the coastlines of the North Pacific into the New World?

In this paper, I bring a relatively global perspective to bear on such questions by examining three related topics: the emergence of anatomically modern humans, the antiquity of maritime adaptations and seafaring, and the peopling of the Americas. Entire books have been written on each of these complex issues, so my discussion of each must be relatively brief and focused on recent developments. In the process, I explore the maritime capabilities of Pleistocene peoples and their potential for discovering and settling the New World by sea, by following a North Pacific Rim route from northeast Asia to the Americas.

Anatomically Modern Humans: An Emerging Consensus?

One of the most intriguing issues in anthropology today involves the evolution of anatomically modern humans (*Homo sapiens sapiens*). Until the late 1980s, anatomically modern humans (AMH) were generally believed to have evolved from discrete archaic *Homo sapiens* populations in several geographic regions of Africa, Asia, and Europe. These archaic humans were in turn thought to have evolved from ancestral *Homo erectus* populations who migrated out of Africa roughly a million years ago¹ (Fagan 1990; Klein 1995). Advocates of this theory of “multiregional evolution,” relying primarily on morphological studies of human fossils, have proposed a relatively high antiquity (ca. 1–2 million years) for the diversity found among living humans and evolutionary continuity between largely discrete lineages *Homo erectus*, archaic *Homo sapiens*, and AMH in multiple regions of the world. Most multiregionalists believe, for instance, that many modern humans of European descent carry the DNA of Neanderthal ancestors within their genetic inheritance (see Smith 1994).

In the late 1980s, molecular biologists and anthropologists proposed a stunning and very different theory. Based on the analysis of mitochondrial DNA collected from the placentas of 189 living women, Cann and colleagues (1987) proposed that AMH evolved first in Africa ca. 150,000 to 200,000 years ago, then spread rapidly around the world replacing all archaic humans. Based on data essentially independent of the human fossil and archaeological records, this controversial “Out of Africa” (a.k.a. the Eve or Replacement) theory proposed just the opposite of the orthodox multiregional scenario. Instead of 1–2 million years to account for modern human diversity, the Out of Africa model proposed a calendar of 200,000 years or less. Instead of the essentially independent evolution of AMH in multiple regions around the world, the Out of Africa theory proposed a complete and relatively recent replacement by a single evolutionary lineage of African origin. And instead of Neanderthals contributing their genes to a communal European inheritance, Out of Africa proponents see Neanderthals as an evolutionary dead end (see Stringer & McKie 1996).

Seemingly consistent with some archaeological and paleoanthropological data, and in conflict with other evidence, the Out of Africa theory has deeply divided paleoanthropologists and archaeologists studying such problems. It has been criticized on numerous counts, from small sample size, to inappropriate statistical analyses, and invalid chronological calibration. Among the most vociferous in this chorus of criticisms have been biological anthropologists who claim that the use of modern DNA to reconstruct evolutionary relationships ignores the fragmentary fossil evidence for transitional stages in the physical development of archaic *Homo sapiens* and AMH. Unfortunately for anthropologists, this last criticism recalls an earlier debate about the ancestry of a 14–17 mil-

lion year old fossil “hominid” jaw dubbed *Ramapithecus*, which molecular biologists studying the biochemistry of modern apes had the audacity to proclaim was much too old to be a hominid. This heated and now historical debate was settled (much to the consternation of many paleoanthropologists) only when a nearly complete *Ramapithecus* skull was discovered and found to be a fossil orangutan (see Lewin 1987).

In the current debate about the origins of anatomically modern humans, paleoanthropologists and archaeologists are themselves deeply divided, with each new discovery eliciting claims from one camp or the other that the new data support their theory. In the meantime, scientists studying human DNA — mitochondrial DNA for maternal lineages, y-chromosome DNA for paternal lineages, nuclear DNA, and even DNA extracted from archaeological samples of Neanderthal and AMH bones — have continued to accumulate a compelling body of data that seems to support the Out of Africa theory. With much larger samples from a wider range of cultures, better analytical and statistical methods, and samples of Neanderthal DNA suggesting that the Neanderthals may have been a separate species² (e.g., Krings *et al.* 1997), an emerging consensus argues that some version of the Out of Africa theory is probably correct (Klein 1995; Mellars 1998).

This consensus is supported not only by molecular data, but by some substantial paleoanthropological and archaeological evidence, as well. As predicted by the Out of Africa theory, for instance, the earliest securely dated AMH skeletal remains have been found in Africa, at Klasies River Mouth Caves in coastal South Africa (Singer & Wymer 1982; Rightmire & Deacon 1991; Klein 1995). These remains, between about 120,000 and 65,000 years old, are associated with Middle Stone Age stone tool assemblages that include the earliest blade technologies, the earliest microlithic geometric assemblages (Howieson’s Poort), and some of the earliest formal bone tools (Mellars 1998). From the Semliki River area of Zaire, recent research also documented the earliest examples of complex barbed bone harpoons and intensive fishing from the Katanda sites, dated to roughly 90,000 to 80,000 years ago (Brooks *et al.* 1995; Yellen *et al.* 1995; Yellen 1998). Also dated to about 90,000 years are the earliest AMH remains found outside of Africa, the Qafzeh and Skhul skeletons from coastal Israel, suggesting that early modern populations had begun to move out of Africa by this time. Curiously, anatomically modern humans do not appear to have moved into most of Europe for another 45,000 to 55,000 years (Klein 1998), possibly held at bay by Neanderthal populations that occupied the area. Current evidence suggests, however, that AMH had spread into southern Asia by at least 70,000 to 60,000 years ago. From there, within just a few millennia, they probably had made the multiple maritime voyages through island southeast Asia that are required to settle Sahul, the larger continent that linked Australia, New Guinea, and Tasmania during glacial periods of lower sea level.

Wherever anatomically modern humans went, at least after about 60,000 years ago, they also seem to have carried with them a penchant for art and symbolism, technological innovation, rapid population growth and geographic expansion, and complex problem-solving and communication skills (see Davidson & Noble 1992; Klein 1998). This creative revolution is evident virtually worldwide during the Late Pleistocene in the invention of a whole series of new technologies and behaviors never seen among our archaic ancestors.³ These include the first chipped stone blade and microlithic technologies, ornaments, complex art and musical instruments, ground stone tools, formal bone and shell technologies, ceramics, basketry, cremations, complex projectiles (harpoons, throwing sticks and darts, the bow and arrow), intensive fishing, and the domestication of plants and animals. Significantly, as we shall see, they also include the first widespread evidence for the development of sophisticated boats and planned maritime voyaging.

Thus, a convergence of molecular, archaeological, and paleoanthropological evidence points toward an emerging consensus — although still vigorously debated — that anatomically modern humans evolved in Africa roughly 150,000 years ago, then rapidly spread around the world in the last 75,000 to 100,000 years, armed with superior intellectual and technological capabilities (Klein 1995; Mellars 1998). In the process, anatomically and intellectually modern humans appear to have replaced the vast majority of archaic humans, although some mixing between AMH and archaic populations may have occurred, with occasional hybrids being swamped in a sea of rapidly expanding anatomically modern populations. Significantly, the Out of Africa model reduces the amount of available time to account for the demographic and geographic expansion of AMH populations by 90 percent or more. As I will show, maritime adaptations and seafaring played a key role in the geographic expansion of *Homo sapiens sapiens*, including some of the most dramatic migrations in human history.

The Antiquity of Maritime Adaptations and Seafaring

For decades, the idea that our Pleistocene ancestors may have made substantial migrations by boat suffered from an anthropological theory that maritime and other aquatic adaptations and seafaring developed very late in human history (see Washburn & Lancaster 1968; Osborn 1977; Bailey 1978; Waselkov 1987; Yesner 1987; and others). This view is clearly illustrated by Yesner (1987:285), who stated that the “historical fact that maritime resources were not exploited until relatively late in the prehistoric record has attracted a general consensus. . . . A real commitment to maritime lifeways did not precede late Upper Paleolithic times.” Through the 1970s, there was virtual unanimity that boats, too, were a relatively recent addition to the human technological repertoire (Bass 1972:12; Greenhill 1976; Johnstone 1980:xv).

Antiquity of Coastal Adaptations: Some Problems and Evidence

On a planet whose surface is almost 75 percent water, where life itself is so dependent on water to survive, and where opportunistic hominids have successfully adapted for millions of years, I find it curious that most scholars believe our ancestors did not adapt to aquatic environments until very recently. The general perception that humans only systematically adapted to marine environments during the last 10,000 to 15,000 years has long inhibited the study of maritime adaptations, coastal migrations, and boats (Erlandson 2001). It tends to peripheralize the significance of aquatic habitats in human evolution, relegating them to an incidental role in a broad-spectrum revolution leading to agricultural societies and civilizations. Thus, maritime adaptations appear to play a marginal role in an important but comparatively brief process in which human ecology departs from its natural course as a population explosion forced humans into increasingly artificial modes of subsistence and production (see Cohen 1977). As Yesner (1987) noted, however, this view of aquatic resources as marginal is out of step with historical and archaeological data that demonstrate that maritime hunter-gatherers were generally more populous and more culturally complex than their non-agricultural interior neighbors.

It is true that there is relatively little evidence for the intensive use of marine resources prior to the end of the Pleistocene (see Waselkov 1987). On a global scale, however, it is not clear whether an apparently dramatic expansion in the use of aquatic resources over the last 10,000 years accurately reflects changes in human subsistence through time. To understand the history of maritime or other aquatic adaptations, globally or in any particular region, we must first determine if the patterns evident in the archaeological record result from actual changes in human behavior, biases imposed on the record by geological or taphonomic forces, or the recovery methods of archaeologists themselves (see Erlandson 2001).⁴

Geologically, there is every reason to believe the archaeological record of coastal adaptations is seriously underrepresented, primarily due to the dramatic swings in global sea levels associated with the glacial and interglacial oscillations of the Pleistocene. During the Last Glacial about 20,000 years ago, for instance, world sea levels stood between about 100 and 125 meters below present, exposing broad coastal plains around the world that have virtually all been inundated as seas rose to their present levels. Similar cycles have occurred numerous times in the last 3 million years, causing enormous, but highly variable, changes in coastal geography around the world. Each time global sea levels have risen significantly, the record of human occupation associated with lower shorelines has either been inundated by rising sea levels, destroyed by associated coastal ero-

sion, or both. Even today, with sea level approximately six meters below the levels of about 130,000 years ago, a number of important coastal sites (Klasies River Mouth caves, Die Kelders Cave, Gorham's Cave, and others) occupied during the Last Interglacial are now being destroyed by marine erosion. In North Africa and the Levant, Lower Paleolithic artifacts have been found in a number of interglacial beach deposits, testifying to the destruction of ancient sites located in coastal settings.

As sea levels rise and fall, coastlines generally move laterally in response to such changes. The maximum lateral movements of coastlines during the last 20,000 years, for instance, have varied from as much as 1000 km in some areas (*i.e.*, northern Australia) to less than a kilometer in others. However, areas where shorelines have moved less than about 10 km are unusual and also tend to be correlated with relatively early evidence for coastal occupations (Erlandson 2001). Reconstructing the ancient landscape in the vicinity of coastal sites is crucial, because a cave or open site located on the coast today may have been 5 km, 10 km, 50 km, or more from the coast at various times during the last 25,000 or 125,000 years. Study of modern coastal hunter-gatherers suggests that they rarely travel more than about 5 or 10 km from a home base to collect food resources (Bigalke 1973:161; Meehan 1982). When they do hunt or forage further afield, the skeletal remains of shellfish, fish, sea mammals, or sea birds are rarely transported much further than this. In most situations, therefore, sites located more than about 5–10 km from an ancient shoreline are unlikely to contain substantial evidence for marine resource use (Wing 1977). During periods of rising or falling sea levels, which encompass most of the Pleistocene, the intensity of aquatic resource use at any given site would have fluctuated depending on (among other things) its proximity to coastal habitats. Since sea level has risen dramatically in the last 18,000 years, most evidence for early marine resource use has almost certainly been inundated or destroyed (van Andel 1989). Furthermore, sites with long occupational sequences located along the modern coast typically show evidence for a postglacial intensification of marine resource use that may be primarily related to changes in local environments rather than a diversification or intensification of human subsistence (see Parkinson 1981; Shackleton 1988).

Despite such problems, a number of early coastal sites have been found (Figure 1). Almost all of these are located in areas where the continental shelf is relatively narrow and lateral movements of the coastline have been limited. Geologically, these are just the kind of places we should expect evidence for early coastal adaptations to be preserved (Richardson 1998; Erlandson 2001). Where shorelines are steep, sites still preserved above sea level may sometimes be found within the foraging radius of ancient coastal habitats. Consequently, sites like the Klasies River Mouth caves (Singer & Wymer 1982) in South Africa, Devil's Tower and Gorham's Cave in Gibraltar (Garrod *et al.* 1928;

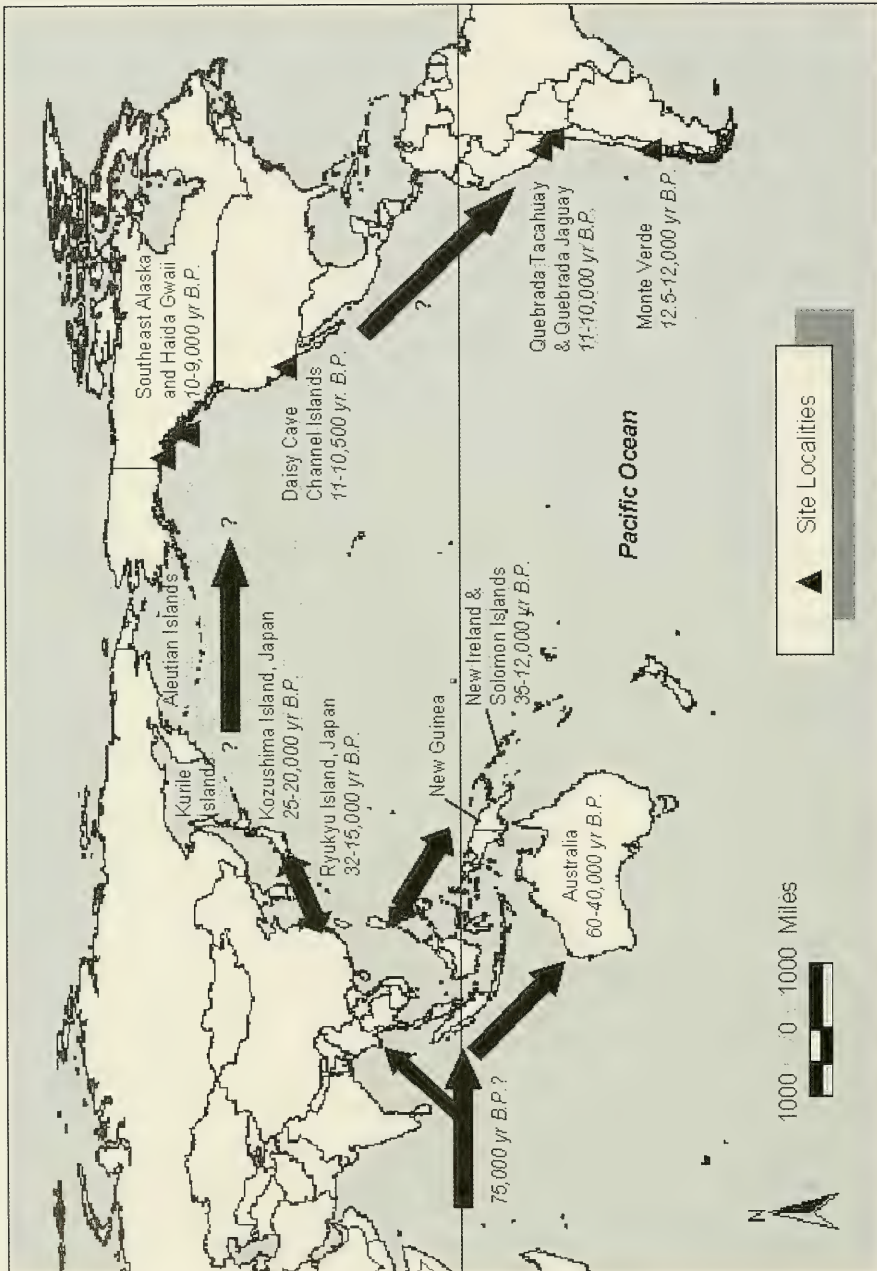


FIGURE 1. Prehistoric sites and areas of coastal habitation on the Pacific Rim, as mentioned in the text.

Waechter 1964), several shell middens located on the Melanesian islands of New Ireland and New Britain (Allen *et al.* 1988; Wickler & Spriggs 1988), and Daisy Cave on California's Channel Islands (Erlandson *et al.* 1996) have all produced evidence for the Pleistocene use of marine resources.

Yesner (1987) suggested that such sites are exceptional and reflect rare instances of early coastal adaptations in areas of unusually high marine productivity. This is true of some early sites, but it does not explain the evidence for early marine resource use at early sites in Italy, Lebanon, Libya, and Algeria (see McBurney 1967; Klein & Scott 1986; Stiner 1994) along the shorelines of the Mediterranean Sea, where marine productivity is generally relatively low (Erlandson 2001). Yesner (1980, 1987) also argued that middle Holocene sea level stabilization was crucial to the formation of extensive shallow nearshore habitats, increased coastal productivity, and the intensification of maritime adaptations, which suggests that steep coastlines should be marginal for human exploitation. Such changes may have enhanced nearshore productivity and marine resource use in some areas, but I suspect that evidence for Pleistocene use of marine resources — including widespread evidence for inland trade or transport of ornamental shells by AMH groups — is the tip of the proverbial iceberg, representing the only visible remnants of earlier and more extensive coastal settlement and adaptations. Until we systematically search for underwater Pleistocene sites, however, we will not know which scenario is correct. Given the nearly endless diversity in the relative productivity and accessibility of marine and terrestrial habitats in coastal zones around the world (see Perlman 1980), moreover, it seems likely that the antiquity and intensity of coastal adaptations varied widely through both space and time.

At present, it is apparent that *Homo erectus* and archaic *Homo sapiens* used marine resources to some extent, but the intensity of such use is unknown and appears to be limited largely to shellfish.⁵ Not surprisingly, anatomically modern humans currently show the earliest evidence for a more intensive use of shellfish and a wider range of marine or aquatic resources. At Klasies River Mouth caves, Die Kelders, and other Last Interglacial localities in South Africa, for instance, AMH appear to have regularly eaten a variety of shellfish, marine mammals, and flightless birds (see Singer & Wymer 1982; Klein & Cruz-Uribe 2000), although some or all of the larger vertebrates may have been scavenged rather than hunted (Binford 1984). At Katanda in Zaire, moreover, comes the earliest evidence for complex aquatic hunting gear, the roughly 85,000 year old barbed harpoons mentioned previously (Yellen *et al.* 1995).

Although the situation is still sketchy, current evidence suggests that the earliest subsistence strategies that included relatively eclectic and intensive use of marine or other aquatic resources may well be associated with AMH. When such aquatic adaptations

were combined with the exploitation of a range of terrestrial plants and animals, the result would have been a more diversified and stable resource base. Such economies may have contributed significantly to the reproductive success of *Homo sapiens sapiens* and our dramatic demographic and geographic expansion of the last 150,000 years (Erlandson 2001).

The Antiquity of Seafaring

The idea that maritime adaptations may have relatively high antiquity, at least among anatomically modern humans, is supported by recent evidence for a relatively early development of seafaring capabilities. It now appears, in fact, that *Homo erectus* in Southeast Asia may have had some seafaring capabilities, apparently settling the Indonesian island of Flores as much as 700,000 to 800,000 years ago (Sondaar *et al.* 1994; Morwood *et al.* 1998). At present, however, there is little other evidence for the use of watercraft by *Homo erectus* or archaic *Homo sapiens* (see Cherry 1990), however, and it appears that such capabilities were relatively rudimentary.

Evidence for more systematic and sophisticated Pleistocene voyaging comes from several coastal regions around the world, but most of it derives from Australia, Melanesia, and eastern Asia, where evidence for voyages in excess of 20 to 200 km has now been widely documented (Table 1). The proof that seafaring extended well back into the Pleistocene requires a major paradigm shift, since maritime voyaging was once thought to be strictly a Holocene phenomenon. Two publications in the 1970s pushed back the antiquity of human seafaring significantly. One of these was the discovery of obsidian from the Mediterranean island of Melos in strata at Franchthi Cave in mainland Greece dated between about 9500 and 13,000 14 C yr B.P. (Cherry 1990). The second was the unequivocal demonstration that humans had reached Australia by at least 20,000 ago (Lampert 1971), a migration that required multiple sea crossings through island southeast Asia, even when sea levels were lowered approximately 125 m during the last glacial. By the mid-1970s, the Australian archaeological record had been extended to about 34,000 years at Lake Mungo (Bowler & Thorne 1976), and subsequent research pushed it back to about 40,000 years (Groube *et al.* 1986), 50,000 years (Roberts *et al.* 1990), and now possibly to 60,000 years or more (Thorne *et al.* 1999).

At first, the Australian data were puzzling for two reasons. First, in historic times Australian Aborigines reportedly had no sophisticated watercraft capable of making substantial sea crossings (Flood 1990:36), which raised questions about their ability to travel through island Southeast Asia by boat. Like much of the rest of the world, Australia also had no true coastal shell middens or other evidence for intensive marine resource

MARITIME VOYAGING AND COLONIZATION OF THE AMERICAS

Table 1. Islands Colonized or Explored by Pleistocene Seafarers.

Locality	Description of Evidence	Age (years B.P.)	References
Flores, SE Asia	Possible evidence for limited seafaring by <i>Homo erectus</i> .	800,000?	Morwood <i>et al.</i> 1998; Sondaar <i>et al.</i> 1984.
New Guinea and Australia	Oldest sites in Suhul are the earliest evidence for planned maritime voyaging, involving multiple sea crossings, some up to 90 km long.	60-40,000	Groube <i>et al.</i> 1986; Roberts <i>et al.</i> 1990; Thorne <i>et al.</i> 1999.
Crete, Greece	<i>Homo sapiens sapiens</i> remains with poorly documented context; calcareous breccia in which bones were cemented dated by Pa/U to $51,000 \pm 12,000$ BP; colonization of Crete apparently required several short sea crossings.	~50,000?	Facchini & Giusberti 1992
Bismarck Archipelago, Melanesia	Shell middens, fishing, and seafaring at several sites dated from 15-35 KYR, with voyages up to 140 km long.	35,000	Allen <i>et al.</i> 1988, 1989; Wickler & Spriggs 1988.
Sicily, Italy	Aurignacian assemblage from Mediterranean Island; possibly involving a sea crossing.	30,000	Chilardi <i>et al.</i> 1996; Cherry 1990.
Ryukyu Islands, Japan	Human skeletal remains found in Yamashita-cho and other caves on Okinawa and other islands; involves voyages of ca. 75-150 km.	32-15,000	Matsu'ura 1996.
Kozushima Island, Japan	Upper Paleolithic peoples on Honshu crossing 50 km wide channel to obtain obsidian.	25-20,000	Oda 1990:64.
Melos Island, Greece	Travel across ca. 24 km of open water to obtain obsidian for mainland trade.	13,000	Cherry 1990.
Admiralty Islands Melanesia	Settlement of Manus Island required 200 km voyage.	12,000	Allen & Kershaw 1996.
Cyprus	Occupation of Aetokremnos site, Akrotiri Peninsula on southwest coast of Cyprus.	10,300	Cherry 1990:151.
Channel Islands, California	Boat and marine resource use by coastal Paleoindian groups, with sea crossings of at least 10 km.	11-10,000	Erlandson <i>et al.</i> 1996; Johnson <i>et al.</i> 2000; Orr 1968.
Southeast Alaska & British Columbia	Presence on islands indicates a maritime lifestyle and seafaring capabilities.	10-9,000	Davis <i>et al.</i> 1989; Fedje & Christensen 1999.

use dating to the Pleistocene. In fact, an overwhelming majority of Australia's coastal shell middens were less than about 5,000 to 6,000 years old. It was sometimes argued, therefore, that Australia was colonized accidentally by castaways, who, stranded in a strange new land, abandoned the coast and adapted to terrestrial habitats. As knowledge of the Pleistocene geography of island Southeast Asia and Sahul accumulated, the cast-away model of the peopling of Australia was rejected on genetic and other grounds (Birdsell 1977; Bowdler 1977). Regardless of the route chosen, the colonization of New Guinea and Australia required several separate sea crossings, including voyages at least 80 km long (Clark 1991). As the antiquity of this migration was pushed progressively back in time, it became clear that the initial settlement of Sahul represented the earliest evidence in the world for planned maritime voyaging.

Confirmation of this scenario came in the late 1980s, when archaeologists investigating the roots of the 3500 year old Lapita cultural complex in western Melanesia discovered several Pleistocene shell middens in the Bismarck Archipelago and the Solomon Islands east of New Guinea (Allen *et al.* 1988, 1989; Wickler and Spriggs 1988). Settlement of these islands, now dated to at least 35,000 yr B.P. (Allen & Kershaw 1996:185), added several significant maritime crossings to those already required to reach Australia and New Guinea. Perhaps more importantly, the sites themselves contained the marine shellfish, fish, and other remains expected of a maritime people. The presence of these Pleistocene shell middens in Melanesia, in contrast to the Australian situation, is due to the fact that coastlines adjacent to the sites plunge steeply into deep water and sea level fluctuations have had a relatively limited effect on the local geography and coastal archaeological record.

The Melanesian evidence also suggests that maritime voyaging capabilities improved significantly between about 35,000 and 15,000 years ago. Although the initial settlement of Sahul, New Britain, and New Ireland required voyages of up to 100 km, for instance, the settlement of Buka in the Solomon Islands at least 28,000 years ago required a minimum sea crossing of 140 km and perhaps as long as 175 km (Irwin 1992:20). By about 15,000 years ago, moreover, roughly the time most scholars think the Americas were first settled, Melanesian seafarers had reached Manus Island in the Admiralty group, which required an uninterrupted voyage of 200–220 km, – km of which was completely out of sight of land (Irwin 1992:21).

Clearly, the relatively warm waters of island Southeast Asia and Melanesia would have posed very different challenges to Pleistocene seafarers than those of the North Pacific and Beringia (Erlandson 1993, 1994:269). Further evidence for Pleistocene seafaring comes from the islands of Japan. Japan itself was connected to the Asian mainland during periods of very low sea level, so its settlement did not necessarily require boats. Fagan

(1990:191) has suggested, however, that the introduction of new blade and edge-grinding technologies about 30,000 years ago took place when Japan was separated from the mainland and probably involved boats. This idea may be supported by the discovery of human bones found beneath a charcoal-rich stratum in Yamashita-cho Cave on Okinawa which has been radiocarbon dated to about 32,000 14 C yr B.P. (Matsu'ura 1996:186). Human remains dated between about 15,000 and 26,000 yr B.P. have also been found in several other limestone caves on Okinawa and the smaller islands of the Ryukyu chain (Matsu'ura 1996), an island arc that stretches southward from Japan nearly to Taiwan. Human remains from Pinza-abu Cave on Miyako Island, found stratigraphically below a calcareous flowstone stratum, were associated with charcoal dated to about 26,000 14 C yr B.P. (Matsu'ura 1996:187). The bathymetry of the Ryukyu Islands area suggests that several sea voyages would have been required to reach Okinawa from Japan, including one crossing roughly 75 km long. Reaching Miyako Island, from either Japan or Taiwan, would have required even longer voyages of up to 150 km.

In Japan itself, archaeological evidence suggests that by at least 21,000 years ago, maritime peoples from Honshu were using boats to procure obsidian from Kozushima Island located approximately 50 km offshore (Oda 1990). As Fagan (1990:191) noted, the first appearance of anatomically modern humans in the Japanese archipelago may have "coincided with the beginnings of seafaring in these temperate waters." Despite the evidence for Pleistocene maritime voyaging, the oldest shell middens in the Japanese islands date to between 9,000 and 10,000 years ago (Aikens & Higuchi 1982). Earlier coastal sites may be submerged offshore.

The presence of Pleistocene maritime peoples in Japan is also significant because it places competent mariners in the cool waters and boreal climates of the North Pacific at a date early enough to have contributed to the initial colonization of the Americas. From Japan, moreover, the Kurile Islands arc northeastward like stepping stones to the Kamchatka Peninsula. From there, the Commander Islands could have provided a base for migration through the Aleutian Islands, although a gap of roughly 250 km would have represented a formidable obstacle. A more likely route would have been to follow the shorelines of the Kamchatka Peninsula northeastward where they would have merged imperceptibly with the south coast of Beringia.

Given the Pleistocene seafaring capabilities of *Homo sapiens sapiens*, the presence of Pleistocene seafarers in the Japanese archipelago, and the geography of the North Pacific, what was once imponderable (Aikens 1990:12) now seems entirely conceivable and increasingly likely. Near the end of the Pleistocene, in Upper Paleolithic Japan and possibly elsewhere in coastal northeast Asia, maritime peoples were situated at the base of a maritime pathway to the New World. Did they make such a journey?

Out of Asia: Migration Routes into the New World

Changing perspectives on the peopling of the Americas are interesting, in part, because they contrast dramatically with colonization models and recent developments in Australian archaeology. The two cases have some interesting parallels — both regions were colonized by AMH relatively late in human history, for instance, and involve the movement of humans into pristine continents untouched by earlier hominids — but the contrasts are even more interesting. Where Australia has been widely viewed as having been colonized by sea, the early settlement of the Americas has traditionally been seen as a terrestrial affair. Over the last 40 years, moreover, the colonization of Australia has been pushed steadily backward in time, while the widely accepted antiquity of human settlement in the Americas has contracted significantly, despite repeated claims for much earlier occupations. When I first began seriously studying archaeology in the 1970s, many introductory textbooks suggested that the Americas were first settled 40,000 or more years ago and many of the earliest sites were considered to be located along the Pacific Coast of North America. At the time, it was widely believed the ice-free corridor was closed between about 40,000 and 70,000 years ago, so some archaeology textbooks suggested that the Americas must have been colonized more than 70,000 years ago. One by one, however, purportedly ancient localities like Old Crow in the Yukon and Del Mar Man, Los Angeles Man, Texas Street, and Santa Rosa Island in California, all succumbed to careful scientific scrutiny, including the redating of several key artifacts or human skeletons using improved analytical techniques, which showed them to be Holocene in age (*e.g.*, Taylor *et al.* 1985). Although there has never been any shortage of new claims for sites older than about 12,000 years, legitimate questions have been raised about virtually all of them, and the 11,000 to 12,000 year old Nenana and Clovis complexes of North America came to be widely accepted as the earliest evidence for human occupation in the New World (see Hoffercker *et al.* 1993). With the widespread acceptance of the 12,500 year old pre-Clovis site of Monte Verde in Chile (Meltzer *et al.* 1997), however, the “Clovis-first” position has come under attack and left many scientists in search of alternative models for the peopling of the New World.

One if by Land: The Ice-Free Corridor

Historically, two main routes have been proposed for the initial colonization of the Americas. Both involve Late Pleistocene migrations by AMH from northeast Asia into North America, but the two models diverge dramatically in the details. The traditional view is that terrestrial hunters walked from northeast Asia into North America across the

arctic plains of Beringia during a glacial period when sea level was relatively low. The land-based scenario involves hearty bands of terrestrial hunters spreading across the Beringian interior, then winding their way into the American heartland via a long and narrow ice-free corridor running between two massive glacial ice sheets.

This story of an epic journey through a 1,500 km long ice-free corridor has captured the imaginations of both archaeologists and the American public for decades. It also seemed to make sense as long as the earliest well-documented sites were the Clovis and Folsom kill sites where Pleistocene megafauna had been butchered by hunters east of the Rocky Mountains. Coastlines were clearly peripheral to this scenario and gave rise to the common perception that land-based Paleoindian hunters gradually radiated outward from the continental center, following game-rich rivers and valleys until they eventually reached the coast and slowly learned to survive in novel marine environments.

This neat scenario ran into some trouble as Clovis and Folsom sites, both dated to relatively narrow periods of time near the end of the Pleistocene, were found further and further from the continental core, except to the north where they should have been relatively abundant and logically the earliest. By the 1980s, fluted Clovis-like points had been found from the Atlantic to the Pacific coasts of North America and from Central America to Alaska, raising questions about where Clovis cultural traditions originated and how they spread so far so fast. The discovery and definition of the Nenana complex in south-central Alaska (Powers & Hoffecker 1989; Goebel *et al.* 1991; Yesner 1996), a logical and slightly earlier precursor to Clovis that lacks fluted points, occurred just in time to save the Clovis-first, big game hunting, ice-free corridor model from collapse. Located far to the south and apparently predating both Clovis and the opening of the ice-free corridor, however, the possibility of a 12,500 year old pericoastal occupation at Monte Verde in Chile raised new questions about when and how the Americas were first settled and brought new attention to the coastal migration theory (see Erlandson 1994:268; Dixon 1999).

Two if by Sea: The Coastal Migration Theory

Recent discoveries and events have breathed new life into the coastal migration theory, which suggests just the opposite of the ice-free corridor hypothesis — that maritime peoples first traveled around the North Pacific Coast then followed river valleys leading inland from the sea. Having a coastal route available, however, does not prove that such a maritime migration took place. Archaeological evidence for early boat use from islands along the western margin of the Pacific may support the idea that such a journey was technologically feasible, but archaeological data from the Pacific Coast of North and

South America are presently ambiguous about the origins of the earliest coastal occupants. I have long argued that many skeptics would not be persuaded that a coastal migration was involved in the initial settlement of the New World until true coastal sites older than the Nenana and Clovis complexes were clearly documented. Such sites have not yet been found, but evidence for the antiquity of coastal settlement, maritime adaptations, and seafaring along the Pacific Coast of the Americas has increased significantly.

Over the years, numerous scholars have proposed that a coastal migration may have contributed to the initial peopling of the Americas (*e.g.*, Heusser 1960; Chard 1963; Laughlin 1967; Fladmark 1979, 1986; Mithun 1979; Gruhn 1988, 1994; Easton 1991; Dixon 1993, 1999; Erlandson 1994; Fedje & Christensen 1999; and others). With the discovery in the 1920s of Clovis and Folsom kill sites in the interior, however, models of the peopling of the New World shifted inexorably towards the interior and the ice-free corridor.

By the 1960s, prevailing thought on the paleogeography of the North Pacific Coast reinforced this shift, suggesting that a coastal route into the New World would have been blocked by massive and continuous accumulations of glacial ice that completely covered the Alaska Peninsula and the northern Northwest Coast. Consequently, the coastal migration theory remained a marginal and all but ignored alternative to the ice-free corridor model. Fladmark (1979) and others have revived interest in a coastal migration route, citing new evidence that glacial refugia existed along the northern Northwest Coast even during the last glacial, that most of the outer coast was deglaciated by at least 13,000 to 14,000 years ago (Mann & Peteet 1994; Mann & Hamilton 1995), and that the ice-free corridor of the interior was far less hospitable to human migration than previously thought. Recent evidence even suggests that an ice-free interior route may only have become available as recently as 11,000 or so years ago (Mandryk 1991; Dixon 1993). Thus a coastal route into the Americas once again seems to be theoretically possible.

There are other reasons for the marginalization of the coastal migration theory, including the old biases against early seafaring and maritime adaptations described above. The most important reason, however, is the fact that for decades the oldest securely documented New World archaeological sites have been found in the American heartland, Nenana, Clovis, and Folsom sites located in interior regions and often associated with the remains of bison and other large game animals. The oldest widely accepted interior sites were dated between about 11,800 and 11,000 14 C yr B.P., while the oldest Pacific Coast shell middens dated to about 9,000 14 C yr B.P. This chronological gap of nearly 3,000 radiocarbon years seemed consistent with a model that big-game hunting and interior occupation came first, followed by migrations to the coast and the development of coastal foraging economies.

With further research, however, fluted Clovis or Folsom-like points have now been found throughout much of North America, including a number of specimens discovered along the Pacific Coast of North America (Erlandson & Moss 1996). Unfortunately, the vast majority of specimens found in the far west have been surface finds or isolates that cannot be precisely dated and have no associated faunal remains to illuminate the nature of Paleoindian economies. While the temporal priority of coastal vs. interior occupation has essentially closed, it is not yet possible to determine if Pacific Coast Clovis peoples were adapted to the sea (Moss & Erlandson 1995).

The Pacific Coast Archaeological Record

Nonetheless, unequivocal evidence for the antiquity of coastal or maritime adaptations continues to be pushed back in time along the Pacific Coast of North and South America. Today, despite significant biases imposed on coastal archaeological records by sea level rise and marine erosion, the gap between Clovis and the earliest documented maritime peoples continues to close and has nearly disappeared in some areas.

A key area in any test of the coastal migration theory is the southern coast of Alaska, comparable to the ice-free corridor in the sense that it links Beringia with temperate North America. In the Aleutian and southwest Alaska coastal areas, several sites dating between about 7500 and 8700 14 C yr B.P. have been found, suggesting that seafaring peoples had colonized the eastern Aleutians and Kodiak Island by at least this time. No earlier evidence of coastal occupation has yet been found, but archaeological research in these areas has been limited and the detailed geological work required to focus any systematic search for early coastal sites has only rarely been done. Although portions of the Kodiak Archipelago are relatively protected, most of the shorelines of this area are also exposed seasonally to very high waves and marine erosion, conditions under which early sites are unlikely to have been preserved.

A different situation exists in the labyrinthine network of islands, estuaries, and heavily forested shorelines of southeast Alaska and British Columbia. Here, many stretches of coast are relatively protected from marine erosion and boat travel is relatively easy in sheltered inside waters. Marine productivity is also very high, with a high ratio of coast-line length to land area, and terrestrial resources are limited. Finally, geological work has shown that postglacial warming and the retreat of glacial ice fields has resulted in isostatic rebound of many coastal landforms, leading to unusual circumstances where shorelines dating between about 8000 and 13,000 years ago are sometimes found in areas above modern sea level. Consequently, the northern Northwest Coast has been the focus

of recent interdisciplinary efforts to find early coastal sites (see Dixon *et al.* 1997; Josenhans *et al.* 1997; Fedje & Christensen 1999; Moss & Erlandson 1999).

One such effort has been the Tongass Caves or Southeast Alaska Caves (SEA Caves) project in the southern Alexander Archipelago (Dixon *et al.* 1997; Moss & Erlandson 1999). In this ongoing interdisciplinary project, archaeologists, geologists, and paleontologists have worked together to reconstruct the sea level, glacial, paleoecological, and archaeological histories of the area. Archaeological and paleontological field studies have focused on caves and rockshelters on Prince of Wales and other islands west of Ketchikan. So far, the earliest secure evidence for human occupation dates to about 9200 14 C yr B.P. at PET-408, where portions of a human skeleton and a microblade-bearing occupational horizon have been documented (Dixon 1999:117-119; Dixon *et al.* 1997). Elsewhere in southeast Alaska, three open air sites dated between about 8000 and 9000 14 C yr B.P. are also known: Groundhog Bay 2, Hidden Falls, and Chuck Lake II (see Ackerman *et al.* 1979, 1985; Davis 1989; Moss 1998). Except for Groundhog Bay, all these early southeast Alaskan sites are located on islands that required boats to settle.

In British Columbia, equally early sites are known, including the mainland site of Namu, dated to as much as 9700 14 C yr B.P. (Carlson 1995) and a number of sites on the Queen Charlotte Islands now known to be 9000 or more years old (Fedje & Christensen 1999). Recent interdisciplinary work on the Queen Charlotte Islands has focused on reconstructing the regional paleogeography to narrow the search for early coastal sites (Fedje *et al.* 1996; Josenhans *et al.* 1997). This work has documented several intertidal sites dated to between about 8000 and 9500 14 C yr B.P. and even dredged a basalt flake from the sea bottom in waters *ca.* 55 m deep, a surface estimated to have last been above sea level about 10,200 years ago (Fedje & Christensen 1999:647). The sheer number of early intertidal and raised beach sites documented on the Queen Charlotte Islands also implies some time for the demographic expansion of coastal peoples to attain that level of archaeological visibility. Unfortunately, it is not currently possible to estimate the length of that process.

On the southern Northwest Coast in Washington, Oregon, and northern California, no shell middens more than about 3500 years old were known prior to about 1985. Even today, the vast majority of coastal archaeological sites within this area date to the late Holocene, but a few early and middle Holocene sites have now been found (Moss & Erlandson 1998). An increasingly compelling body of literature now implicates geological forces as playing a significant role in the dearth of early coastal sites (Minor & Grant 1995; Erlandson *et al.* 1998, 2000; Moss & Erlandson 1998). This area is located adjacent to what is known as the Juan de Fuca plate and the Cascadia Subduction Zone, where geological evidence suggests that very large earthquakes associated with tsunamis and

accelerated marine erosion occur every few centuries. It now appears that large portions of the coast may drop a meter or more during such earthquakes, raising sea levels virtually instantaneously and leading to severe marine erosion (Peterson *et al.* 2000). Despite these processes, two shell middens dating to roughly 8000 14 C yr B.P. have been found along the southern Northwest Coast in the last decade, the Indian Sands (35-CU-67) site on the southern Oregon Coast (Moss & Erlandson 1998) and the Duncan's Rockshelter site (CA-SON-348) on the northern California Coast (Schwaderer 1992).

The earliest evidence of maritime adaptations and seafaring in North America currently comes from California's Channel Islands, which have remained separated from the mainland throughout the Pleistocene and could only have been settled by boat. At Daisy Cave on San Miguel Island, an ephemeral but stratigraphically discrete shell midden lens containing a few chipped stone artifacts has produced radiocarbon dates on marine shell ($10,600 \pm 70$ and $10,700 \pm 90$ 14 C yr B.P.) and wood charcoal ($10,390 \pm 130$ 14 C yr B.P.) that indicate that the cave was briefly occupied by maritime Paleoindians during Folsom times (Erlandson *et al.* 1996). Stratigraphically above this terminal Pleistocene stratum is a series of much denser shell midden layers dated between about 9700 and 8000 14 C yr B.P. that have produced abundant shellfish and fish remains, sea mammal and sea bird bones, stone tools, bone bipoints (fish gorges), and shell beads. At Arlington Springs on the northwest coast of Santa Rosa Island, Orr (1962, 1968) also found human bones in a paleosol buried 37 feet (*ca.* 11 m) below the surface. Early dates on charcoal and the bones of Arlington Woman suggested that she died roughly 10,000 years ago (Erlandson 1994:186), but recent AMS dating using advanced extraction and decontamination techniques suggests that her true age may be closer to 10,500 or even 11,000 14 C yr B.P. (Johnson *et al.* 2000). The Channel Islands have also produced numerous other early Holocene sites that corroborate the presence of early seafaring peoples off the California Coast. Along the mainland coast of central and southern California, more than 30 coastal sites have been dated between about 9500 and 8000 14 C yr B.P. (see Erlandson & Moss 1996:285–287).

In South America, even earlier evidence for coastal adaptations has been found (see Richardson 1998). This includes apparent evidence for the use of coastal resources at Monte Verde in Chile, where seaweed and asphaltum reportedly derived from coastal habitats may date to as much as 12,500 14 C yr B.P. (see Dillehay 1997). At the Querero site north of Santiago, Nunez and colleagues (1994) reportedly found marine shellfish, sea lion, and whale remains associated with the bones of terrestrial animals, with a series of radiocarbon dates ranging between about 11,600 and 10,900 14 C yr B.P. (Richardson 1998). Llagostera (1979) has also documented the existence of diversified maritime economies on the northern Chile Coast dated to as much as 9700 14 C yr B.P.

In Peru, where Richardson has demonstrated a positive correlation between the presence of early coastal sites and steep offshore bathymetry, evidence for coastal settlement and marine resource use now appears to extend back over 11,000 years. The earliest evidence comes from the Quebrada Jaguay site along the south coast, where charcoal samples from a shell midden containing abundant shellfish, fish, and sea bird remains have been dated to *ca.* 11,000 14 C yr B.P. (Sandweiss *et al.* 1998). Keefer and colleagues (1998) reported similar remains from another Peruvian midden dated to *ca.* 10,700 14 C yr B.P. and the basal strata at the Ring site shell midden produced a similar date (Sandweiss *et al.* 1989). Richardson (1998) also reported the presence of the remains of shellfish collected from mangrove habitats at a series of ephemeral campsites in the Talara region of northwest Peru, sites dated between about 9000 and 11,200 14 C yr B.P. In Ecuador, coastal shell middens of the Las Vegas complex have also been dated between about 9500 and 10,800 14 C yr B.P. (Stothert 1985).

On the Notion of "Negative" Evidence

Although there is still no clear evidence for the presence of fully maritime or seafaring peoples along the Pacific Coast of North and South America before Clovis times (*ca.* 11,250 $\pm$ 250 14 C yr B.P.), the gap has all but disappeared in places and earlier coastal sites will almost certainly be found in other areas. As I have noted, there is also reason to believe that early Pacific Coast archaeological records have been heavily affected by sea level rise, marine erosion, and other factors (Richardson 1998; Erlandson 2001). The effects of such processes vary along different stretches of the Pacific Coast, depending on variation in offshore bathymetry, wave energy, geology, and other attributes. Contrary to earlier assertions (*i.e.*, Osborn 1977), however, there are no known areas of the Pacific Coast where shorelines between about 13,000 and 25,000 years old are currently above (or even near) modern sea level (Richardson 1998). Thus, we are still missing a key component of the geographic and archaeological records relevant to understanding the initial colonization of the Americas. I am not suggesting that Clovis or pre-Clovis age sites definitely exist along the continental shelves of the Pacific Coast, but without conducting a systematic search for such sites we will never be able to answer crucial questions about the peopling of the New World.

The prospect that even older sites may exist on the continental shelf raises an interesting problem in the debate about the history of maritime adaptations and the coastal migration theory. This is the issue of what to do with what is sometimes referred to as "negative" evidence. The objection is relatively simple and straightforward: Many scholars insist, even if we know that the data we have may be biased, that we must build our

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models of the past based on the archaeological evidence we have at hand. Therefore, even if rising postglacial seas drowned the world's coastlines — and possible evidence for early marine resource use or coastal migrations with them — we cannot assume that such sites exist and build our models on negative evidence. Without tangible evidence for such adaptations or migrations, we must assume that they did not exist, circumstantial evidence simply doesn't cut it.

I sympathize with this view to some extent: Our reconstructions must be governed by some reasonable rules of evidence after all. On the other hand, I also believe that as scientists we must be more open about what we know and don't know, and more clearly recognize that there are many major issues about human history that we are unable to resolve with currently available data. I believe questions about the antiquity of maritime societies and the possibility that Pleistocene seafaring peoples colonized the Americas are among those that cannot currently be answered with any sense of authority. To answer such questions we need more evidence and much of the evidence we need is beneath the sea, in the presence or absence of submerged Pleistocene archaeological sites. It is one thing to suggest that maritime adaptations may have developed late in human history, especially with caveats, but quite another to talk of historical facts when the archaeological record remains ambiguous.

It surprises me, too, that so many archaeologists have essentially disregarded or dismissed the significance of the geological processes (sea level rise, marine erosion, etc.) that structure the archaeological record of the world's coastlines. I don't expect everyone to endorse the idea that deeply drowned sites will be found, only to accept the possibility that archaeological records on land may be significantly biased and that further research is needed to determine the nature and extent of such biases. Since the 1970s, virtually no one has seriously questioned that the Pleistocene colonization of Australia, New Guinea, and western Melanesia involved maritime peoples in seaworthy watercraft. Yet the idea that maritime peoples may have colonized the Americas during the Pleistocene has been dismissed as relying on negative evidence that may or may not exist along drowned Pacific Coast shorelines. Such pronouncements would be easier to accept if comparable skepticism was applied to terrestrial alternatives. What evidence is there, for instance, that people walked across the now drowned plains of Beringia on foot? Why has the unlikely construct of a long and narrow ice-free corridor teeming with game remained the dominant paradigm for the peopling of the Americas for decades, despite relatively limited evidence for its existence, its suitability as a human habitat, or the presence of archaeological sites of Clovis or greater age?

Given the emerging evidence for the technological sophistication and rapid geographic spread of anatomically modern humans, the antiquity of maritime adaptations,

the presence of Pleistocene mariners on the eastern shores of the Pacific Ocean, and the nature of late glacial environments in northwestern North America, it is time for a sea change. I am not suggesting that we discard the concept of an ice-free corridor that may have played a significant role in the peopling and early history of the Americas. I believe, however, that the most likely scenario emerging from data derived from a variety of disciplines will show that the colonization of the Americas was a complex process that involved multiple waves of migration, out of Asia and into the New World, and quite possibly by both land and by sea.

Summary and Conclusions

To summarize, just over 10 years ago, conventional views on human evolution suggested that: 1) anatomically modern humans developed independently in several areas of the Old World, descended from ancient *Homo erectus* populations that spread out of Africa about a million years ago; 2) coastal adaptations and maritime voyaging played little or no significant role in human history until about 10,000 to 15,000 years ago; and 3) the Americas were first settled about 12,000 years ago by small bands of terrestrial hunters who marched relatively rapidly across a Beringian land bridge, down the fabled ice-free corridor, into the heart of North America, and on to the southern tip of South America.

Today, we still have much to learn and large geographic and temporal gaps to fill. Nonetheless, data emerging from a variety of disciplines suggest a very different story. They suggest that anatomically modern humans probably evolved in Africa about 150,000 years ago then rapidly spread around the world, largely replacing archaic human populations. If this Out of Africa model is essentially correct, we are left with only about 5 to 10 percent of the time allowed for in our old models to account for the demographic and geographic expansion of *Homo sapiens sapiens*. It also appears, at least after about 100,000 years ago, that our anatomically modern ancestors were more sophisticated intellectually and technologically than previous models gave them credit for.

The new data also tell us that aquatic adaptations and seafaring played a more significant role in the demographic expansion, the geographic spread, and the phenomenal success of our species than previously supposed (Erlandson 2001). This notion is supported by the earliest evidence for relatively effective use of a wider range of marine resources by AMH in a series of Last Interglacial sites located along the coast of southern and eastern Africa. It appears to be supported by the use of composite harpoons associated with abundant freshwater fish remains in Zaire by about 80,000 to 90,000 years ago. Finally, it is clearly indicated by the evidence for Pleistocene seafaring from

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Australia, New Guinea, Melanesia, Okinawa, and Japan dating between at least 50,000 and 15,000 years ago.

Among the last three major colonizing migrations undertaken by humans (Australia, the Americas, and the Pacific Islands), at least two appear to have involved planned maritime voyaging. Circumstantial evidence from the eastern Pacific suggests that several Late Pleistocene Asian populations also had watercraft and the ability to make significant sea voyages. Given the geography and paleoecology of the North Pacific, Beringia, and Northwest North America, I have argued that it is increasingly likely that boats played a significant role in the colonization of the Americas. Although it can be argued that such a migration may well have taken place, more tangible evidence will be required to prove that such a migration actually occurred (see Yesner 1996).

I don't know when and how the Americas were first settled, but I do know that a coastal migration theory recently considered by many to be imponderable has moved into the realm of the possible or even the probable. Ironically, the coastal migration theory that once was considered by many scholars to be marginal now appears relatively conservative when compared to media and scholarly accounts of Pleistocene Australians or Polynesians crossing the open Pacific, or Europeans crossing the open Atlantic. Despite such claims, I believe the earliest occupants of the New World were the ancestors of the Native Americans who lived in the Americas when the Vikings and Columbus made their pioneering voyages across the Atlantic. This "Out of Asia" scenario is supported by such an overwhelming body of linguistic, biological, genetic, and archaeological evidence, that its basic premise seems highly unlikely to change.⁶ Thus, if a coastal migration was involved in the initial colonization of the Americas, the Pacific coastlines of North and South America are the logical places to search for the evidence.

I believe a compelling case can now be made that we need to increase the levels of funding and effort directed towards identifying archaeological evidence for Pleistocene coastal occupations in North and South America. The difficulties involved in finding coastal sites older than 11,000 or 12,000 radiocarbon years are serious, but not insurmountable. To increase the chances of success, such searches should be focused on areas with relatively steep continental shelves, on caves or rockshelters and springs (in arid coastal areas) or other features that may have drawn maritime peoples inland from Pleistocene shorelines, or on submerged semi-protected coastlines where marine erosion is least likely to have destroyed drowned terrestrial sites. Such research should be carefully planned and conducted within an interdisciplinary framework that includes geological analysis of paleoshorelines and landscapes, consideration of the sedimentary and depositional regimes that may affect the preservation and visibility of ancient sites, and the identification of areas most likely to have been used by early maritime peoples.

Abstract

After the appearance of anatomically modern humans about 150,000 years ago, evidence for technological innovation, marine resource use, and seafaring all increase dramatically. Intentional maritime voyaging appears to have developed sometime after about 75,000 years ago, contributing to some of the most important migrations in human history, including the peopling of Australia, western Melanesia, and the Pacific Islands. Evidence for Pleistocene seafaring in Southeast Asia and Australia — along with recent archaeological and paleoecological evidence from both North and South America — has helped revive the notion that the Americas also may have been settled by maritime peoples. Evidence that Pleistocene voyaging contributed to the initial colonization of the New World is still largely circumstantial, but a variety of data suggest that it is increasingly likely that such a maritime migration took place. I suspect, in fact, that the Pleistocene colonization of the Americas may have included both land-based migrations through the Beringian interior and maritime voyaging around the North Pacific Rim.

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Endnotes

¹ Recent redating of *Homo erectus* specimens from Java suggests that these hominids may have reached Southeast Asia as early as 1.6 to 1.8 million years ago (Swisher *et al.* 1994).

² Krings and colleagues (1997) isolated a small segment of DNA from a sample of Neanderthal bone from a site in Germany. They found that the Neanderthal DNA was three times as different from modern standards as the genetic diversity evident among modern humans, suggesting that Neanderthals represented a species separate from our own.

³ Recent discussions of the Chatelperronian complex in southwest Europe, long regarded as an Upper Paleolithic cultural tradition, suggest that Neanderthals may have made some ornaments, formal bone tools, and blades about 35,000 to 40,000 years ago as anatomically modern humans were moving into the region. However, it is still not clear that the Neanderthal remains found in two Chatelperronian sites represent the makers of these typically Upper Paleolithic objects. The Neanderthal remains could have been deposited by AMH occupants of the sites, Middle and Upper Paleolithic materials may have been mixed within a single stratum by trampling or other disturbance processes, more advanced materials could have been traded or given to Neanderthals by AMH, or they could result from Neanderthal mimicry of the material culture of a more sophisticated society.

⁴ Although space does not permit me to discuss these in detail here, it has long been known that screening of excavated archaeological sediments, especially screening over mesh sizes of 1/8-inch (*ca.* 3 mm) or smaller, is usually necessary to recover a representative sample of the remains of many aquatic animals, including small fish and shellfish. The fact that faunal remains were not systematically collected from many early coastal or riverine sites raises the possibility that our understanding of early aquatic resource use patterns may be seriously biased (see Erlandson 2001).

⁵ Fish bones from Hoxne in England, probably dated to *ca.* 300,000 years ago, may be an exception. In distributions that correlate well with those of artifacts and terrestrial fauna, numerous freshwater fish bones were recovered by sieving the site sediments (Stuart *et al.* 1993:163, 198). It is uncertain, however, if the fish remains were of cultural or natural origin.

⁶ Despite relatively intensive research, there currently is no evidence for occupation of any Pacific Islands outside of western Melanesia, Okinawa, and Japan earlier than about 5,000 years ago. Although coastal migrants around the North Pacific could have shared common ancestors with Austronesian peoples, the idea that Polynesians reached

the Americas in the Pleistocene makes little sense, because distinctive Polynesian cultures did not emerge until about 3500 years ago. Despite some interesting technological parallels, the idea that Europeans crossed the Atlantic to colonize the Americas during the Pleistocene (see Stanford, this volume) contradicts a vast body of genetic, linguistic, biological, and archaeological evidence and currently seems unlikely.

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CHAPTER FIVE

FACING THE PAST: A VIEW OF THE NORTH AMERICAN HUMAN FOSSIL RECORD

D. Gentry Steele and Joseph F. Powell



Anthropologists' interest in North America's human fossil record has risen and fallen since scholars first became interested in who the first Americans were, how the New World continents were colonized, and when. During the first half of the 20th century, for example, prehistoric skeletal remains formed the data base for the first models developed to explain the peopling of the Americas (*e.g.*, Hrdlicka 1902, 1907, 1918, 1923, & 1937). However, during the second half of the century, research focused less often upon the ancestry and affinities of the North American Indians, and more upon ecological issues, such as how populations adapted to the various environments in which they lived, and the lifestyles they followed (*e.g.*, Armelagos *et al.* 1982).

The shift away from issues concerning the origins of American Indians was caused by several factors. One major factor was Ales Hrdlicka's conclusion that the colonization of the New World was a very recent event. This view was founded upon Hrdlicka's conclusions that the North American human remains being proposed as ancient which he had examined were all anatomically modern in appearance compared to the Neanderthal remains recovered in Europe. Further, Hrdlicka was convinced that all proposed ancient remains were assignable to times following the extinction of the megafauna of the last ice age of the Pleistocene (Hrdlicka 1902, 1907, 1918, & 1923). In Hrdlicka's view, Europe had archaic forms of humans who co-existed with the cold-adapted Pleistocene megafauna while the land of the Americas lay virgin to the human footprint. The recession of the Pleistocene ice masses and the spread northward from the equator of warmer climates saw the demise of the cold-adapted biological populations and their replacement by the biological populations whose descendants lived into historic times. This changing face of Europe was the theater in which Hrdlicka believed the Neanderthals evolved into the anatomically modern humans. In the Americas, however, it was not until after the end of the Ice Age and the establishment of the recent and biological communities that the first humans, anatomically modern compared to the

Neanderthals, crossed from northeastern Asia via the Bering Strait to colonize the New World. Linking Hrdlicka's model with the prevalent view of the times that natural selection molded populations at an almost imperceptibly gradual rate, there would not be enough time since the end of the Pleistocene for anatomical changes to have occurred in the modern human populations.

With the European Neanderthals as his standard of reference for archaic humans, Hrdlicka's assessment that all skeletal remains found in the New World were anatomically modern and resembled anatomically modern extant Native American populations provided the substantive underpinnings to the model.

Two additional lines of evidence, which supported Hrdlicka's model of the recent colonization of the Americas, were the close resemblance of extant Native Americans to Northeast Asians compared to other Old World populations, and the inferred high degree of similarity within and between the populations within the Americas. With the above model in place, and the European Neanderthals as the standard of reference for early human populations, what could be learned from the continued study of the relatively recent human remains from the Americas concerning their origins or their dispersion within the Americas?

The basic tenets of this robust model have survived virtually unscathed even though: 1) human entrance into the New World occurred at least during the final phase of the Pleistocene, earlier than the original model considered possible; 2) many of the North American skeletal remains, accepted as ancient and recognized as indistinguishable from extant Native Americans, have been found to be much more recent in age than previously suspected, and are not representative of the early populations in the New World; and 3) that we have gained knowledge about how populations change through time, and the rates that changes can occur within an evolving lineage.

Currently, however, there is renewed interest in how, where, and by whom the peopling of the New World occurred. This renewed interest has been brought about in part by challenges to the widely held assumption that the oldest remains were indistinguishable from the most recent populations, and by the discovery of more complete remains whose great antiquity (more than 8,500 years old) is firmly established. Examination of the recent discoveries such as Kennewick Man (Chatters 2000, Powell & Rose 1999), in Washington and the recently dated Spirit Cave, and Wizard's Beach skeletons from Nevada (Tuohy & Dansie 1997) have confirmed the initial inferences about the distinctiveness of the earliest known American remains from more recent North American human skeletal remains. Examination of these recent finds have documented their resemblances to Old World populations, most commonly those of central and southern Asia and other populations of the Pacific Rim.

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We will concentrate upon the recent studies of the oldest remains to indicate the nature of the craniofacial shape that is used as evidence to challenge the long held opinions about how the earliest known colonizers of the Americas looked, and to consider the significance of this new perspective. Because of the equivocal nature of results based on samples limited in numbers and represented by fragmentary remains, most scholars have chosen to compare very recent samples which are represented by more complete and less comminuted remains. However, without examining the earliest human remains, it is impossible to test the assumption that the historical record has little to add to the story of the peopling of the Americas.

Early Reconsiderations

When we began to re-evaluate North America's human fossil record (Powell 1993; Powell & Steele 1992; Steele 1989; Steele & Powell 1992, 1993, 1994), the samples we considered securely dated, and complete enough for at least limited multivariate comparisons consisted of no more than 10 individuals (Table 1). Of these, only two males from Browns Valley and Sauk Valley, Minnesota, (Figure 1) and two females, one from Gordon Creek, Colorado, and one from Pelican Rapids, Minnesota were complete enough for 13 measurements to be taken. Ironically, two of these proved later to be of early Archaic antiquity and the impact of this will be discussed below.

These early Holocene samples were compared to more recent world populations using principal components analysis (PCA) and canonical variate analysis (CVA). Both multivariate statistical procedures compare populations on the basis of many traits simultaneously. The samples are dispersed in a multidimensional space based upon the sum of the weighted comparative difference of each trait. Within this universe of samples, the distance of each sample from the other is a reflection of their dissimilarity. The dispersion of the samples within this universe can be visualized as a conventional three-dimensional graph where the first two axes identify a plane through the universe that best separates the sample. The third axis used for the three dimensional plot is at an angle to the other two axes. The relative importance of each trait in establishing the difference between the samples is determined by the position of the planes within the universe of samples. Of the two multivariate procedures, the CVA requires the researcher to first identify related samples. Therefore, the procedure is effective at comparing clusters of known populations with one another and comparing the amount of variation within a group to the variation between the groups. PCA establishes the distinctiveness of each sample by comparing it to all others without defining clusters of similar samples. In practice PCA requires the researcher to make fewer assumptions about the data, and this usually results in samples which could be grouped together geographically to be more dis-

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persed from one another. This tendency was reflected in our PCA of samples from the same geographical region (and therefore, samples presumed to have a greater degree of shared genes), while samples from different geographical regions overlapped more closely. While this resulted in less discriminating power, we felt the technique more accurately reflected the biological underpinnings of the statistical measures of similarity.

TABLE 1. Paleoindian samples from North and South America. List includes only those specimens complete enough for one or more craniofacial measures to be taken and used in multivariate analyses. For a complete listing of Paleoindian remains see citations listed.

Site	Sample Size	Nature of Remains	Age (yr B.P.)
White Water Draw ¹	2	skeletons	8,000 - 10,000
Gordon Creek ¹	1	skeleton	8,700 $\pm$ 250
Browns Valley ¹	1	skeleton	8,700 $\pm$ 110
Pelican Rapids ¹	1	skeleton	(Early Archaic)
Sauk Valley ¹	1	skeleton	(Early Archaic)
Wilson-Leonard ¹	1	skeleton	9,000 - 11,000
Horn Shelter ¹	2	skeletons	9,000 - 10,000
Spirit Cave ²	1	skeleton	
Wizard's Beach ²	1	skeleton	
Kennewick ³	1	skeleton	8,410 $\pm$ 50
Station do Riacho			
Lapa Vermelha ⁴	1	skeleton	11,000 - 12,000
Cerca Grande ⁴	8	skeletons	9720 $\pm$ 130

1. Sample used in early statistical studies of Paleoindian studies by Steele and Powell (1992, 1994). Brown's Valley and Pelican Rapids were considered Paleoindian in age at time of original studies.

2. Additional North American sample used by Jantz and Owsley (1997) and Steele and Powell (1999), and Powell and Neves (1999).

3. Additional North American sample used in study by Chatters (2000), Powell and Rose (1999), and Powell and Neves (1999).

4. South American Paleoindian skeletons used in Powell and Neves (1999).

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Figures 2 and 3 are the PCA plots based on size corrected data for males and females from the two early Holocene males from Minnesota, and the Minnesota and Colorado females. A third female skull, the Wilson-Leonard II female (Figure 4), was too crushed to be accurately measured, but visually, her features were quite similar to the Minnesota and Colorado females. Figure 5 illustrates the process of preparing a facial reconstruction of Wilson-Leonard II. The Minnesota specimens were all recovered during the 1930s, while the Colorado specimen was recovered in the 1960s. These early Holocene samples are compared to recent samples of populations located throughout the World (Howells 1969, 1973, 1989).

For the males (Figure 2), the six recent North American samples are clustered near the center of the graph, in proximity to the Northeast Asian samples on one side, and European and southern Pacific Rim (including the Australians) samples on the other. The Paleoindian female sample (Figure 3) lies along the periphery of the American Indian cluster of samples (crosses), within the cluster of southern Pacific Rim and

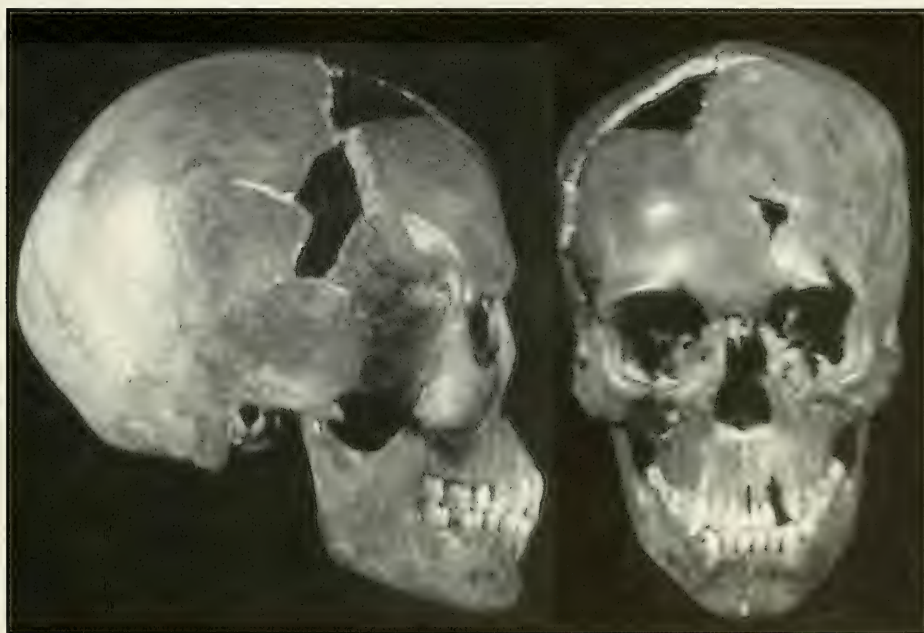


FIGURE 1. Paleoindian female from Pelican Rapids, Minnesota. Initially considered to be of the antiquity of other Paleoindian remains (predating 8,500 yr B.P.), the most recent ^{14}C date indicated the age was comparable to North American remains associated with the Early Archaic (post 8,500 yr B.P.).

Australian samples, and away from the Northeast Asian samples. The European samples are widely dispersed in the upper half of the graph: Some appear to be more similar to Northeast Asian samples, while others appear more similar to the southern Pacific Rim samples. The female sample (Figure 3), analyzed separately, provided a similar picture.

Bivariate analyses (Figures 6 & 7) of the measurements were used to clearly identify which Paleoindian cranial features were most distinctive (Steele & Powell 1992, 1994). By using these simpler statistics requiring only two measurements for analysis, the Paleoindians could be compared to a larger number of samples including some samples recovered from mid-Holocene deposits. Figure 6 documents that both male and female Paleoindians generally have relatively narrower and longer braincases than most recent American Indians. Populations with shorter and broader braincases are in the upper left portion of the bivariate plot, while populations with relatively longer crania, such as the North American Paleoindians, fall toward the lower right quadrant. Notice that samples closer, and therefore more similar, to these Paleoindians are from Archaic (*e.g.*, Indian

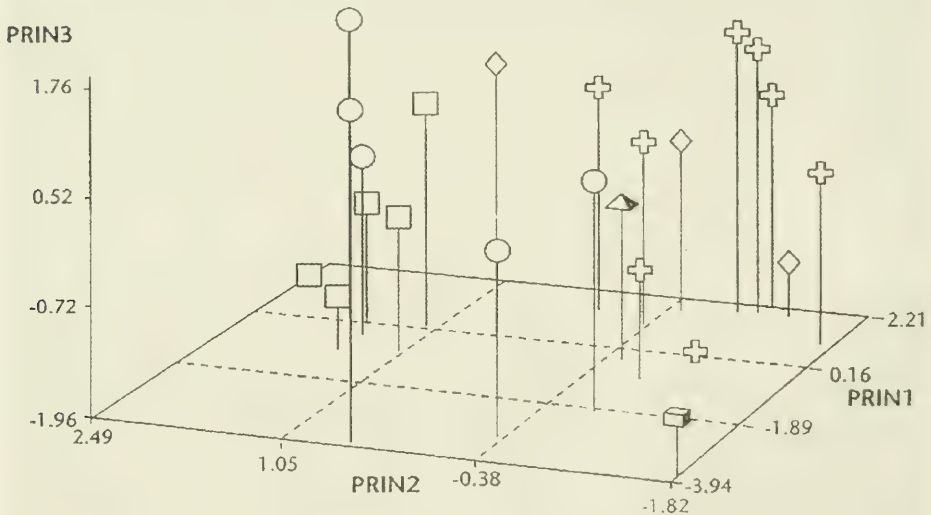


FIGURE 2. Principal Components plot of the first three components (PRIN 1, 2 and 3) illustrating relative differences between male Late Pleistocene/Early Holocene and recent samples on basis of eight size-corrected measurements of face and braincase. The distance of symbols from one another reflects their differences. Early samples are Paleoindians (pyramid); Upper Cave, China (cube); Minatogawa, Taiwan (flag) and Jomon, Japan (cylinder). Samples representing more recent populations are North American Indians (cross), Northeast Asians (diamond), peoples of the southern Pacific Rim (open circle), and Europeans (open square). (After Steele and Powell 1994.)

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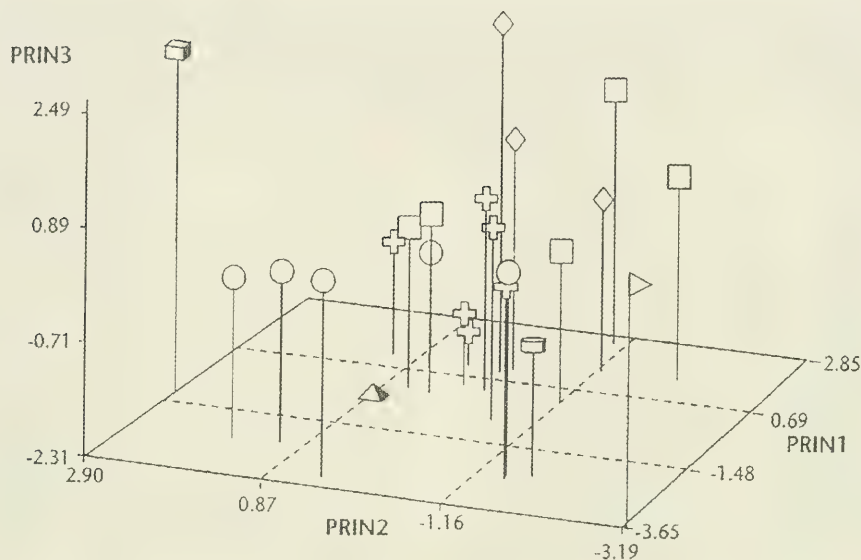


FIGURE 3. PCA plot of the first three components (PRIN 1, 2 and 3) illustrating relative differences between female samples representing Late Pleistocene/early Holocene and recent populations on the basis of eight size-corrected measurements. The distance of symbols from one another reflects their differences. Early samples are Paleoindians (pyramid) and Upper Cave, China (cube). Samples of more recent populations are Northeast Asian (diamond), southern Pacific Rim (open circle), and Europe (open square). (After Steele and Powell 1994.)

Knoll and Tennessee Archaic) rather than Late Prehistoric times. When comparing these Paleoindians to southern Asians, Europeans, American Indians and northern Asians, the Paleoindian samples tend to resemble Australians and southern Pacific Rim populations in their long and narrow braincases rather than the northern Asians. Figure 7 documents the narrower and shorter faces of Paleoindians compared to more recent Native American populations. Again, Paleoindians cluster more closely with Australians and samples from the Pacific Rim and southern Asia, than they do with northern Asians (see Tables 4 & 5 of Steele & Powell 1994 for a listing of the sites and mean dimensions of measurements used in these figures).

After publishing these results, we were provided with opportunities to examine two virtually complete crania from Nevada that were recently found to be approximately 9,500 years old. The two Nevada specimens, the Spirit Cave mummy (26CH1F) and the Wizard's Beach individual (Figure 8) (26WA1605) were recovered in the 1940s and 1950s, respectively, but have only recently been radiocarbon dated. The antiquity of the Spirit



FIGURE 4. The Wilson-Leonard female cranium from Leander, TX. Although this skull has been securely dated to be 9,500 years old, the skull was too badly crushed to be measured accurately. Her features, however, closely resembled those of the Gordon Creek and Pelican Rapids females.

Cave individual is 9410 ± 60 14 C yr B.P., based upon seven dates of bone and hair material. The antiquity of the Wizard Beach individual is 9515 ± 155 14 C yr B.P., based upon one bone date. Both individuals were adult males, and were very well preserved (Jantz & Owsley 1997; Steele & Powell 1999).

Because the Nevada skulls were much better preserved than the two male Minnesota specimens it was possible to compare them to recent crania using 28 measurements of the skull and face. In this analysis the two Nevada specimens were treated as representing separate populations. Figure 9 illustrates the PCA based on the size-corrected data comparing the two Nevada samples to 25 more recent American Indians, Europeans, northern Asians, Polynesians, southeastern Asians, and Australians. (Eigenvectors and eigenvalues for these PCA are presented in Tables 1 & 2 of Steele & Powell 1999.) The most striking feature of this analysis is the distinctiveness of the Nevada individuals from more recent samples, as well as their distinctiveness from one another. However, they still more closely resemble Polynesians and Australians than they do American Indians and Northeast Asians.

Figure 10 shows the relationship of Nevada males and the Minnesota males based on 13 size-corrected measurements which was the maximum number of measurements

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which could be taken on the Minnesota specimens. Both the Nevada and the Minnesota samples again lie on the periphery of the North American Indian samples and close to Polynesian and Australasian samples, further from the northern Asians.

Considering these studies, it appears that the exact relationship of the Paleoindian samples to other populations differs depending upon the samples compared, upon how many measurements are used in the analysis, and how measurements are made. In spite of these variations in the results, a generalized pattern can be seen. First, Paleoindian samples fall within a broad cluster of samples composed of samples from the Pacific Rim including northern and southern Asians, American Indians, Polynesians, and Australians. Second, the Paleoindians consistently appear more similar to southern Asians, Australians and populations of the southern Pacific Rim than they do northern Asians. The features which the Paleoindians share with these southern Asian and Pacific Rim peoples are a long and narrow braincase and a relatively short, narrow face.



FIGURE 5. The male cranium from Wizard Beach, Nevada is one of the most complete crania of an individual considered of the antiquity of Paleoindians (predating 8,500 yr B.P.).

These resemblances of Paleoindians to more recent populations of the world, first reported in 1992 (Steele & Powell 1992) were affirmed in both the male and female samples from two different localities, and samples that were analyzed using different data sets of 13 and 28 measurements. When the two Nevada Paleoindian crania were considered representative of a single population, and compared to the Minnesota Paleoindian males and the more recent comparative samples on the basis of 13 cranial measurements, the Nevada early Holocene remains fell within the dispersion of the late Holocene remains. However, when the early Nevada remains were compared to the more recent samples on the basis of 28 measurements, which provided a more detailed characterization of the skulls, the early Holocene Nevada remains were located at the periphery of all the samples. This demonstrated that these two specimens could not comfortably be assigned to any of the subclusters.

Kennewick Man

The recent discovery of a human skeleton of early Holocene age near Kennewick, Washington, has focused national and international attention upon America's fossil record and the question of the ancestry of the first Americans. The skeleton, that of an adult male, later called Kennewick man, was recovered from the Columbia River near Kennewick in July 1996. The well-preserved remains, including a skull with the facial skeleton complete enough to permit a large body of measurements to be taken, was dated at 8410 ± 50 14 C yr B.P., which is approximately 9,500 years old in calendar years (Chatters 2000). More recently, three additional 14 C dates were taken on Kennewick Man's bony remains for the Department of the Interior (MacManamon 2000). Two of the three dates (8130 ± 40 & 8410 ± 60 14 C yr B.P.) are virtually identical to the first date obtained and reported by Chatters. The third date (6940 ± 30 14 C yr B.P.) confirms the antiquity of the Kennewick Man even though this date deviates from the other three dates by at least 1000 years. Kennewick Man has become one of the most securely dated human fossils in the Americas.

Currently the focal point in a lawsuit between eight scientists and the Department of the Interior, the preliminary analyses of Kennewick Man have yet to be verified. Two preliminary studies have been published: One is by Chatters (2000) based upon his examination of the remains before the lawsuit was filed and the other study is by Powell and Rose (2000) which was authorized by the Department of the Interior after the lawsuit was filed. To satisfy an issue raised by the lawsuit, Powell and Rose specifically assessed whether the Kennewick Man would be identified as an ancestor of a specific extant North American Indian group. To address this issue, Kennewick Man was compared to extant and late Holocene world populations using 10–52 measurements depending upon

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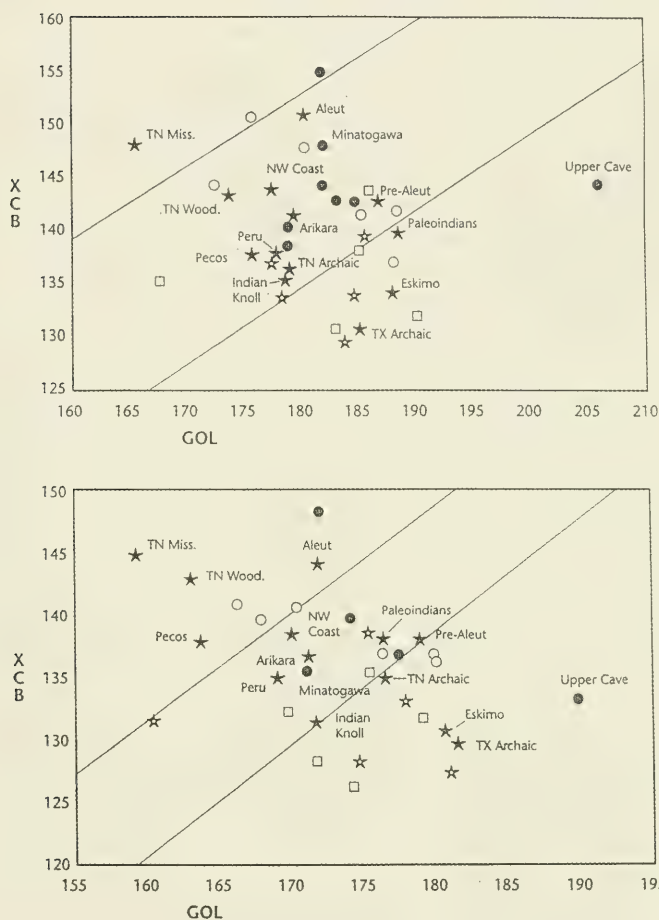


FIGURE 6. Bivariate plots of male (upper plot) and female (lower plot) samples compared on basis of cranial length (GOL) and width (XCB). Diagonal lines mark traditionally recognized boundaries for identifying wide crania (upper left), narrow crania (lower right), and crania of moderate width (central area) relative to length. Samples representing populations are Paleolindians and more recent samples of North American Indians (solid stars), Asians and late Pleistocene/early Holocene samples of Minatogawa and Upper Cave (solid circles); Australians and southern Pacific Islands (open stars), Africans (open squares), and Europeans (open circles). Individual samples are identified for North American Indians, Paleolindians, and the late Pleistocene/early Holocene Upper Cave and Minatogawa samples. (After Steele and Powell 1992.)

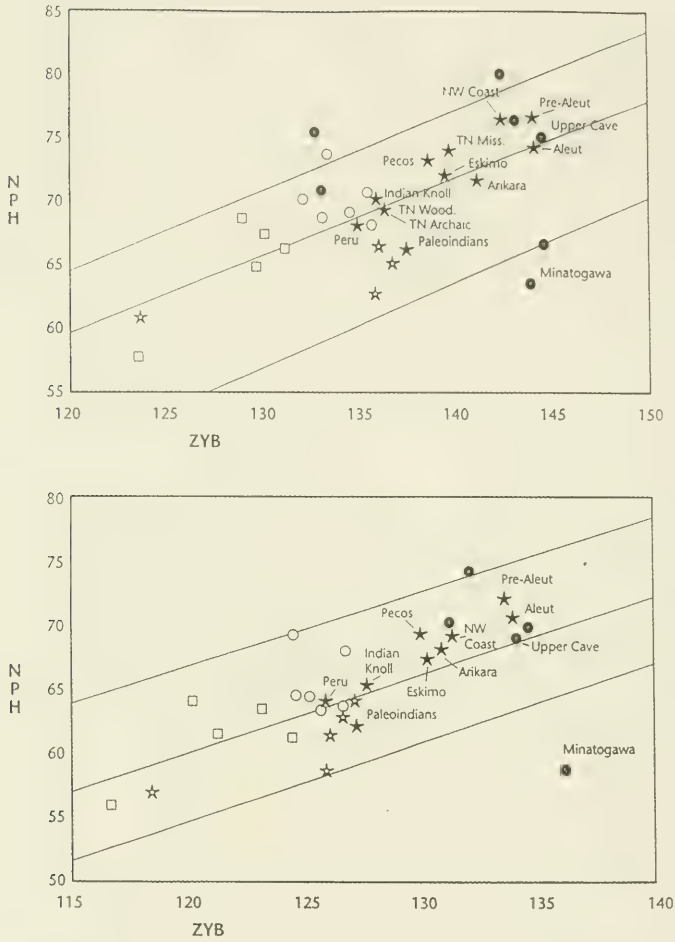


FIGURE 7. Bivariate plots of male (upper plot) and female (lower plot) samples compared on basis of facial width (ZYB) and facial height (NPH). Diagonal lines mark traditionally recognized boundaries for identifying wide crania (upper left), narrow crania (lower right), and crania of moderate width (central area) relative to cranial length. Samples representing male populations (upper plot) and female populations are Paleolndians (solid stars) and North American Indians (solid stars), more recent Asians and late Pleistocene/early Holocene samples from Upper Cave, China and Minatogawa (solid circles), Australians and southern Pacific Islands (open stars), Africans (open squares), and Europeans (open circles). Samples individually identified in the figure are North American Indians, Paleolndians, and the Late Pleistocene/early Holocene Upper Cave and Minatogawa samples. (After Steele and Powell 1992.)

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the completeness of the human remains of the samples compared. The samples were compared to Kennewick Man using CVA and PCA based upon primary and size-corrected craniofacial measurements. Consistently in these studies Kennewick Man was structurally midway between North American Indian groups and southern Pacific Rim populations. Depending upon the analysis, they were most similar to populations such as Maori, Ainu/Jomon, or Polynesian. When Kennewick Man was compared to other geographical groups using larger data sets the dissimilarity of Kennewick Man from all recent human groups became apparent. However, even in these studies which emphasized Kennewick Man's dissimilarity, the recent populations which most closely resembled Kennewick Man were consistently southern Asian or Pacific Rim populations. Probability studies indicated that Kennewick Man would not be a member of any recent North American Indian group, nor would it fall morphologically within any other living human worldwide population. Comparative studies using discrete traits of the cranium and of the dentition also documented the distinctiveness from recent North American Indian populations. Comparing Kennewick Man to Archaic American Indian samples and recent human populations, Kennewick Man more closely resembled crania from the Archaic Indian Knoll sample, an Ainu/Jomon sample, and pooled Northeast Asian and southern Asian populations. Studies of discrete features of the cranium and the dentition both substantiated the distinctiveness from the extant American Indians. Summarizing their results from all analyses, Powell and Rose concluded (1999):

Like other Early American skeletons, the Kennewick remains exhibit a number of morphological features that are not found in modern populations. For all craniometric dimensions, the typicality probabilities of membership in modern populations were zero, indicating that Kennewick is unlike any of the reference samples used. Even when the least conservative inter-individual distances are used to construct typical probabilities, Kennewick has a low probability of membership in any of the late Holocene reference samples. Similar results were obtained by Ozolins *et al.* (1997) for Upper Paleolithic samples from Asia, Africa and Europe and Paleoindian groups, and are not surprising considering that Kennewick is separated roughly by 8,000 years from most of the reference samples in Howell's (1989) and Hanihara (1996). The most craniometrically similar samples appeared to be those from the south Pacific and Polynesia as well as the Ainu of Japan, a pattern observed in other studies of early American crania from North and South America (Steele & Powell 1992, 1994; Jantz & Owsley 1997).

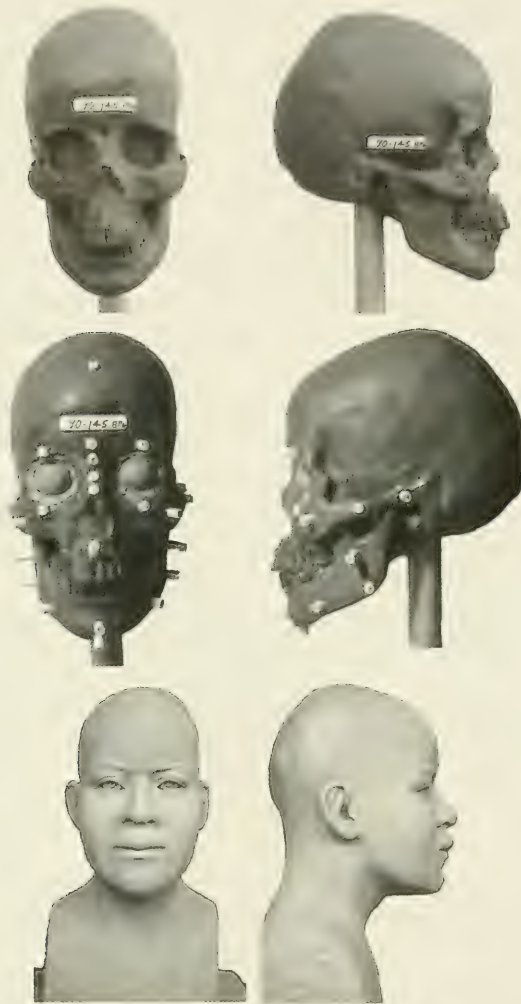


FIGURE 8. Frontal and lateral views of the Wilson-Leonard II adult female during three stages in the process of a preparing facial reconstruction based on the skull. The top pair shows a reconstruction of the crushed skull. The center pair shows the reconstructed skull with markers indicating the predicted depth of facial tissue at key points on the skull. The tissue depth at each point is based upon mean tissue depths determined for world samples. Asian standards were used in the facial reconstruction. The bottom pair the reconstructed face prepared by Betty Pat Gatliff, a world-renowned forensic artist. The facial reconstruction was made for the Houston Museum of Science. Photographs are by Betty Pat Gatliff.

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Early Holocene Remains from South America

As the distinctiveness of the face and braincase of early Holocene samples from North America was being recognized and reported, Walter Neves and his colleagues were documenting the distinctiveness of the earliest Holocene samples recovered in South America (*e.g.*, Neves & Pucciarelli 1989, 1991, 1998; Neves, Meyer, & Pucciarelli 1996; Neves, Munford & Zanini 1996; Neves, Zunimi, Munford & Pucciarelli 1997; Neves, Powell, Prous & Pucciarelli 1998; Neves, Powell & Ozolins 1999; Powell & Neves 1999). Using bivariate and multivariate statistics, the body of their work clearly documented the difference of the early Holocene samples from late Holocene samples from South America, and the craniofacial similarities of the early Holocene remains to Australian, African, and southern Pacific populations. Recent analysis of the earliest known human remains from South America, a young adult female from the site of Lapa Vermelha IV thought to be about 12,000 years old, has confirmed the distinctiveness of

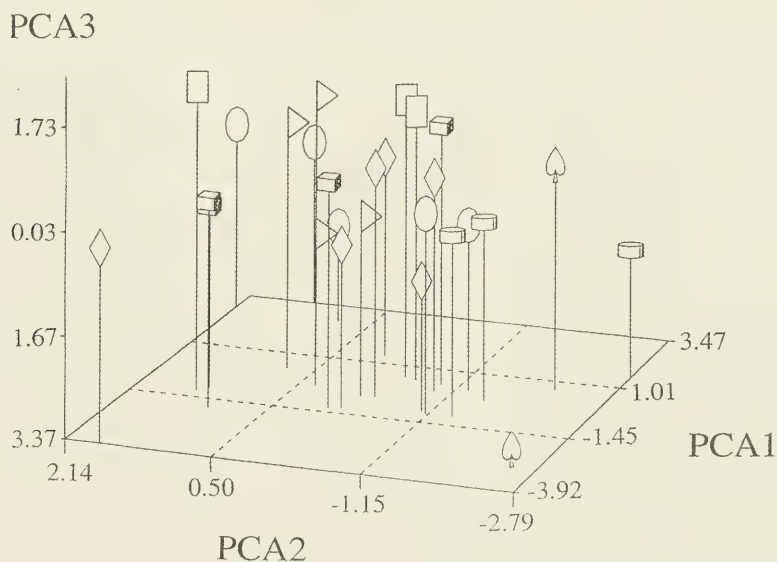


FIGURE 9. PCA plot of the first three components (PCA 1, 2 and 3) illustrating the relative difference between male samples based on 28 size-corrected measurements of the braincase and face. The distance between samples represents their relative difference. Samples representing populations are the Spirit Cave and Wizard's Beach, Nevada Paleoindians (spades), more recent American Indians (cubes), Europeans (rectangles), Northern Asians (diamonds), Polynesians (cylinders), Southeast Asians (flags) and Australians (ovals). (After Steele and Powell 1999.)

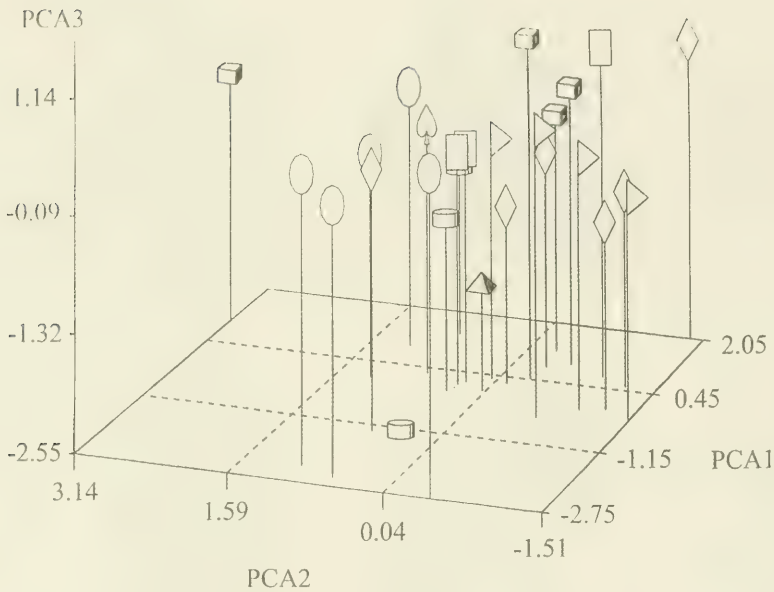


FIGURE 10. PCA plot of the first three components (PCA 1, 2 and 3) of male samples based on 14 size-corrected measurements. Distance between samples represents their relative difference. Samples representing populations are Nevada Paleolindians (spades) considered to represent a single population, the other Paleolindians (pyramids) considered a single population distinct from the Nevada Paleolindians, American Indians (cubes,) Europeans (squares), northern Asians (diamonds), Polynesians (cylinders), Southeast Asians (flags), and Australasian (ovals). (After Steele and Powell 1999.)

the early South Americans (Neves *et al.* 1999). Figure 11 illustrates the structural similarity of the face and braincase of the Hominid 1 female from Lapa Vermelha IV compared to a worldwide selection of populations measured by Howells (1973, 1989). The Lapa Vermelha IV Hominid 1 female is markedly similar to the African populations (Doggo, Yeit, Zulu), while the Asian and European populations form a loose second cluster. The Australian and one Polynesian sample form a third cluster. Previous studies also had documented the similarity of South American remains to the African and Australian samples, particularly the Australian samples.

Figure 12 (Powell & Neves 1999) illustrates how the structural similarities between the major continental populations appear when they are considered at the 90% confidence limit. The distinctiveness of the Paleolindian samples from the late Holocene American Indian samples is still apparent even though the continental populations overlap. The only sample completely separated from the Paleolindians are the American

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Indian samples. On the other hand, both the Paleoindians and North American Indians overlap with all other continental clusters of populations. The populations with which the present Paleoindians most closely correspond are the Polynesian, then the Northeastern and Southeastern Asian samples.

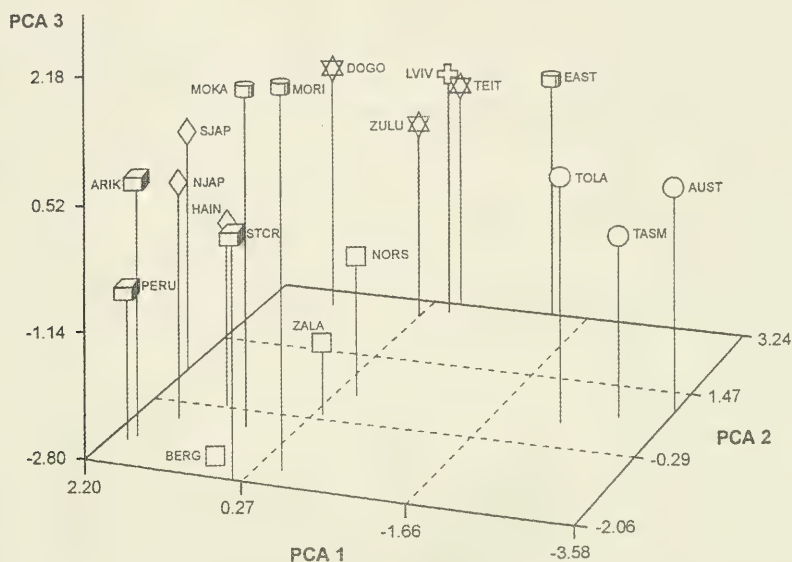


FIGURE 11. PCA plot of the first three components (PCA 1, 2 and 3) illustrating differences between South American Paleoindians and other samples based on 28 size-corrected measurements. Distance between samples is a reflection of their differences. Samples representing populations are South American Paleoindian Vermelha IV (crosses), Africans (stars), Asians (diamonds), Australasian, American Indians (cubes), Polynesians (cylinders), and Europeans (squares). (After Powell and Neves 1999.)

Early and Mid-Holocene Comparisons

As it became clear that the earliest remains from both New World continents looked different from the recent American Indians and Northeast Asians, the next step was to compare the Paleoindians with prehistoric North American skeletal remains from the middle Holocene to determine when the change occurred. One of the authors (JP) was one of the first scholars to specifically address this issue. In his dissertation on dental variation in prehistoric American Indians, Powell (1995) compared the Paleoindian sam-

ple from North America with early to mid-Holocene remains. Powell's conclusions were that, whereas Paleoindians were typically distinct from late Holocene samples from North America, they much more closely resembled remains from the mid-Holocene swath of time.

With the similarities between mid-Holocene and Paleoindian remains being documented on the basis of dental structures, the next step was to determine if the same similarities could be recognized in the size and shape of the braincase and face. Powell and Neves (1999) documented the morphological relationships of the North American Paleoindians and South American Paleoindians with the North American Archaic populations (Figure 13). The distribution is based on a multidimensional scaling of Mahalanobis' distance measurements where, again, the distance between two points is a reflection of their structural similarity.

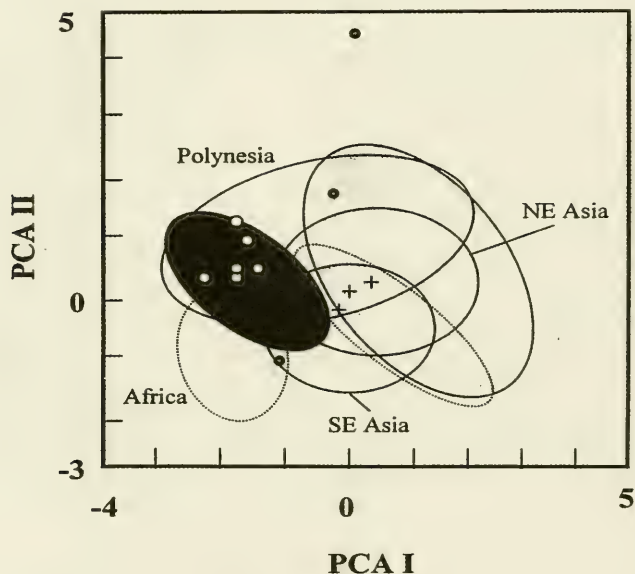


FIGURE 12. Bivariate plot of first two components (PCA 1 and 2) of a Principal Component Analysis illustrating the extent of variation at 2 90% confidence limit. Distribution of samples is based on a Q-mode analysis of 14 variables. Light gray ellipse reflects variation within North and South American Indians, and the dark ellipse represents variation among Australians. Ellipses of Europeans, Northeast Asians, Europeans, Southeast Asians and Polynesians are identified. The position of individual North American Paleoindians (solid circles), individual South American Paleoindians (open circles), and the centroid positions for Jomon and Ainu samples (crosses) are individually marked. (After Powell and Neves 1999.)

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In Figure 13, three of the North American Paleoindians cluster reasonably well together and in a position midway between the South American Paleoindians and the North American mid-Holocene to late Holocene human remains. The South American samples form a tighter cluster than the North American Paleoindians and the Archaic skeletal remains from North America. There are two remains, one from the Archaic group and one Paleoindian which are far removed from their cohorts. They clearly indicate the amount of variation, which probably existed in the early and mid-Holocene American populations, that is being underestimated.

The last point we emphasize here is that the North and South American Paleoindians show as great a dispersion as the Archaic and more recent North American Indian samples. Previously, the high degree of homogeneity observed in living Native American's soft tissue features such as hair color and form, eye color and form, led scholars to assume that the total gene pool of Native American Indians was homogeneous. This

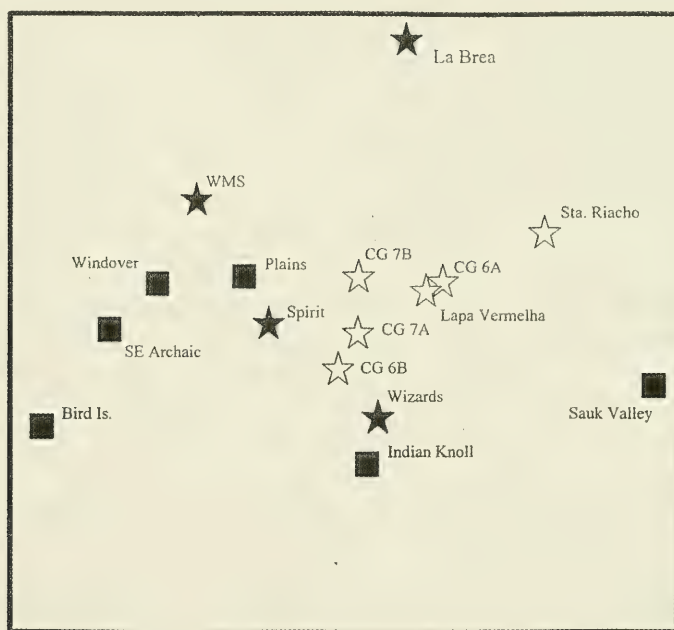


FIGURE 13. Distribution of North American Paleoindians (closed stars) and South American Paleoindians (open stars) compared with Archaic American Indian samples (solid squares), based on multidimensional scaling of Mahalanobis distances between individual Paleoindians and centroids of Archaic samples. Paleoindians are plotted individually. The positions of the Archaic samples are the centroid position for the sample. (After Powell and Neves 1999.)

perceived homogeneity was thought to exist because the initial colonizers were few in number, were from a single region within northeast Asia, and that the earliest colonizers and their descendants had not been in the New World long enough for natural selection to shape them to local conditions. With our current awareness of the heterogeneity of American populations, we can no longer assume a recent colonization of the New World. Awareness of this heterozygosity also means that each Paleoindian and Early Archaic find will have an extraordinary potential for providing new information about America's earliest colonizers.

Summary

In summary, the research over the past 10 years has documented the following: 1) The earliest remains recovered from the Americas have consistently been found to have a craniofacial shape that is distinguishable from the more recent Prehistoric and extant populations; 2) The North American Paleoindians resemble more closely the features of living and Late Prehistoric Southeast Asians than they do Northeast Asians; 3) The South American Paleoindian remains resemble more closely the North American Paleoindian craniofacial form than they do any other American Indian groups (living or dead); 4) The South American Paleoindians, while resembling North American Paleoindians, differ from them by more closely resembling Australian and African samples than do the North American Indian populations; 5) The Paleoindians from both American continents are structurally more similar to Archaic (mid-Holocene) populations than they are to Late Prehistoric and living American Indians; and 6) There is as much variation in early and mid-Holocene populations as there is in Late Prehistoric populations.

What is the Meaning?

Since the reconsideration of the American fossil record began in the 1980s (Neves & Pucciarelli 1989; Steele 1989), several explanations have been proposed to explain the differences between the Paleoindian remains and the Late Prehistoric and extant American Indians. Table 2 summarizes explanations which have focused upon the Paleoindian samples to explain their differences from the earliest and most recent populations.

Table 3 summarizes models proposed to understand the colonization of the New World continents. The most mechanical of these explanations is that the characteristics of the Paleoindian specimens that have been documented are not an accurate reflection

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TABLE 2. Alternative explanations focusing upon the Paleoindians to explain why they differ from recent American Indians.

Explanation	Support	Negating evidence
Explanation 1: Sampling Error: Paleoindians presumed to look like late Holocene humans, but sampling errors create a false impression of Paleoindian population.	Very small sample sizes.	All but one comparison of Paleoindians have documented their similarity to one another and their distinctiveness from late Holocene samples.
Explanation 2: Paleoindians differ from extant American Indians because they represent a distinct population derived from Southeast Asia. This Southeast Asian derived population later replaced in New World by populations derived from Northeast Asia.	Explains distinctiveness of recent American populations from founding population and similarities to recent Northeast Asians.	Assumes that cranial and facial features reflect the ancestral genotype. Does not consider possibility of evolutionary forces occurring in the Americas which may account for the dissimilarity of Paleoindians from extant American Indians.
Explanation 3: Paleoindians differ from extant Northeast Asians and American Indians because they represent an earlier Northeast Asian population before the evolution of the more distinctive facial features of more recent populations.	Explains the distinctiveness of Paleoindians and the later similarities of Northeast Asians and American Indians.	Does not consider effects of evolutionary forces.
Explanation 4: Distinctive features of the braincase and face of living American Indians were created by the evolutionary forces of genetic drift and gene flow, rather than the features reflecting an unaltered ancestor/descendant relationships.	Incorporates evolutionary models in explanation.	Must assume parallel evolutionary forces acting on Northeast Asian and American populations if both differ from Paleoindians in the same way.

of the actual Paleoindian population as it existed. The reason for this proposed inaccurate image of the Paleoindians is that the measurements based on the very small samples of Paleoindians deviate from the mean measurement of the complete population to such an extent that they do not reflect the average or the normal configuration of the parent population from which they came. From the inception of our research (Steele & Powell 1992, 1994) we acknowledged the potential danger of evaluating such small samples, and presented our findings each time as preliminary assessments. However, as each new study based on different Paleoindian samples from new localities consistently substantiated our initial assessment it became clear that the early Holocene samples did indeed document that Paleoindians were different from late Holocene and extant populations.

Once it was apparent that the differences between the earliest populations in the New World differed from the most recent New World populations, the question became, what evolutionary forces, or a combination of forces, created the differences? Could we assume that the similarities principally were shared features with the ancestors? Alternatively, could the differences principally be caused by forces such as genetic drift or natural selection acting upon the New World populations as they adapted to new environments, new biological communities, and new lifestyles?

Until recently, the most widely held view was that if the features of the face and braincase of two skeletal samples, separated in time or space, resembled one another, the similarities reflected a genetic link. Such similarities between two species separated in time have been the foundation for interpretations by paleontologists unearthing the history of all animals. A related inference has been that natural selection has been the primary force creating the differences which have developed through time. These assumptions are reasonable at higher levels of generalizations such as when comparing two species or genera.

Adopting these inferences in studying the colonization of the Americas, the resemblances of the recent Northeast Asians and American Indians were assumed to reflect their genetic ties to one another. When the oldest samples were also thought to resemble the more recent American Indians and Northeast Asians, as Hrdlicka concluded, the evidence was complete. If the descendants looked alike and the ancestor looked like the descendants, the only inference considered likely was that they were related, and that the most ancient of the samples represented the founding colonizers.

When the evidence suggests the founding population resembles more closely another population, such as Southeast Asia, or a more generalized ancestral Asian population, the reasoning still applies. The assumption is that the founding population is genetically linked to the one it resembles. In this model, the Northeast Asians and American Indians are assumed to have in common a more recent colonizer to the New World than either

TABLE 3. Alternative models to explain the forces which have created the craniofacial features of North American Indians.

Old World Founding Population	New World Evolutionary Forces	Resemblances of Extant American Populations to Founding Population	Assumptions and Supporting Evidence for Model	Negating Evidence and Limitations of Model
Model 1: Single founding population identified as Northeast Asian.	None or minimal.	Does not accept evidence of North American fossil record. Infers features of founding population from shared features of recent American Indians and Northeast Asians.	Extant Northeast Asian and American Indians are very similar. Distinctiveness of Paleoindians due to sampling errors.	Paleoindian remains consistently differ from extant American Indians.
Model 2: Single founding Old World population, usually identified as Protoasian or Northeast Asian, followed by one or more Old World populations, also considered to be from Northeast Asia.	None or minimal.	Descendant American population differs from each of the founding populations, but shares characteristics with each population.	Extant American Indian populations are distinct from Asian populations, but heavily influenced by Northeast Asian populations.	Model does not consider possible evolutionary forces acting on population after arrival in New World.
Model 3: Single founding population, usually Northeast Asian or Southeast Asian.	Genetic drift during early phase of colonization followed by period of reuniting populations through gene flow.	Descendant American populations resemble ancestral populations to a degree, but differ because of unique evolutionary history after colonization.	Includes evolutionary forces in model with enough time for them to act upon founding populations.	Does not effectively explain similarity of American Indian populations if founding population is not like extant Northeast Asian.
Model 4: Single or multiple founding populations from Asia and possibly Europe.	Natural selection.	Population shares some features with founding populations, but is distinct due to natural selection acting on populations in local environments.	Considers possibility of evolutionary forces in New World.	A distinctive pattern that would identify natural selection as the process has not been found.

has to the earlier colonizers who more closely resembled the Southeast Asians. The picture may become even more complicated if there has been gene flow between the first founding population and later arrivals and their descendants. However, the guiding assumption is the same, the resemblances seen are presumed to reflect genetic ties.

Lahr (1995) examined the underlying assumptions of this working principle using two New World populations. She compared the craniofacial features of historic South American hunters and gatherers of Tierra del Fuego, a population near the Antarctic Circle, to Eskimos near the Arctic Circle. Both populations are adapted to cold, dry conditions, yet in all models each is derived from a separate Pacific Rim population. In both populations she found similar superficial craniofacial resemblances which she inferred were the results of adaptation through natural selection to similar, but geographically separated cold environments. The overall shape and size of the face and braincase of the Tierra del Fuegians, however, resembled most closely southern Pacific Asian populations rather than South American populations or Eskimos.

Lahr's research then, supports models that envision basic shape and dimensions of the face and braincase as being relatively conservative and tending to reflect ancestral descendant relationships while natural selection, acting over a relative short term, molds more superficial features. Addressing the issue of the colonizing of the Americas specifically, Lahr's evidence supports a model that: 1) recognizes the distinctiveness of the Paleoindian samples, and infers that the ancestors for Paleoindians were either from Southern Asia or southern Pacific Rim, or possibly representative of a proto-Asian population with more generalized features; and 2) subsequent changes to American Indian populations craniofacial features reflect gene flow from more recent Northeast Asian ancestors as well as the possible effects of natural selection acting upon local populations adapting them to local conditions.

While Lahr's work indicates how natural selection may work in conjunction with the transmission of genes through time, the power of genetic drift and gene flow to shape small isolated populations as they spread into a new world was not examined. Powell and Neves (1999) in a review of the craniofacial morphology of the First Americans did address the effects these evolutionary forces could have on early American populations and their descendants. Specifically, they assessed whether the pattern of resemblances observed between early, middle, and late Holocene skeletal remains, which we outlined above, also could support a model that attributed these differences to evolutionary forces such as genetic drift combined with gene flow.

They proposed that genetic drift acting on small isolated founding populations could create as great or a greater amount of variation within the early and middle Holocene as seen in late Holocene and extant populations. More recently in time, they suggested it

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would be possible for the isolating mechanisms separating the populations could break down and gene flow could tie the populations to one another and create the range and pattern of genetic variation we see in American Indians during Late Prehistoric and historic times. In this model then, the founding population could have had the craniofacial shape and dimensions that we and others have found, and then as the founding population expanded into the New World small populations became isolated, drift occurred, followed by breakdown of the isolating mechanisms which could have resulted in the configuration of the American Indian populations in historic times.

The foundation for this model is Wright's (1951) measure of within-group genetic variation (F_{st}) of extant populations modified to permit estimates of heritability of craniofacial dimensions, shape, and the estimates of the size of prehistoric populations (see Powell & Neves 1999 for a discussion of procedures). Using these modifications, Powell & Neves (1999) first calculated the F_{st} , Wright's (1951) measure of within-group variation, and used this to estimate between group variation by combining population into one sample and estimating that group's F_{st} . In cases where the F_{st} of the combined sample was in the range of the expected within-group variation for a single population, it was estimated that these two samples could represent a single population. If the F_{st} was much greater than the average F_{st} , it was inferred that the two samples represented separate populations, and including them within one sample was an artificial construct. When Powell and Neves (1999) computed these values for a selection of world populations, and New World Paleoindians, the Paleoindians had a much higher divergence than the degree of variation found within later Holocene remains. This supported the assumption that the Paleoindians were distinct from American Indians.

The distinctiveness of the Paleoindians from other populations also was determined using Relethford and Blangero's (1990) modified technique of estimating within-group variation. In this analysis, the difference between the average variance for all samples was compared to the variance within the individual populations. Using the difference as a distance measure between samples indicated how likely they were to be members of a single population. Figure 14 (1999) illustrates the distribution of world samples and Paleoindians using two different estimates of population size for Paleoindians in the computation of within-group variation. In Figure 14A the population size was estimated to be equal to all other samples, while in Figure 14B Paleoindian population size was estimated to be 0.30 the size of more recent populations. In Figure 14A both Eskimo and Paleoindian samples are distinct from all other samples in terms of variance from the average indicating they represent separate populations from the others. When the amount of within group variance is recalculated using a smaller estimated population size for the Paleoindians alone, their variance falls within the range of variation of the other

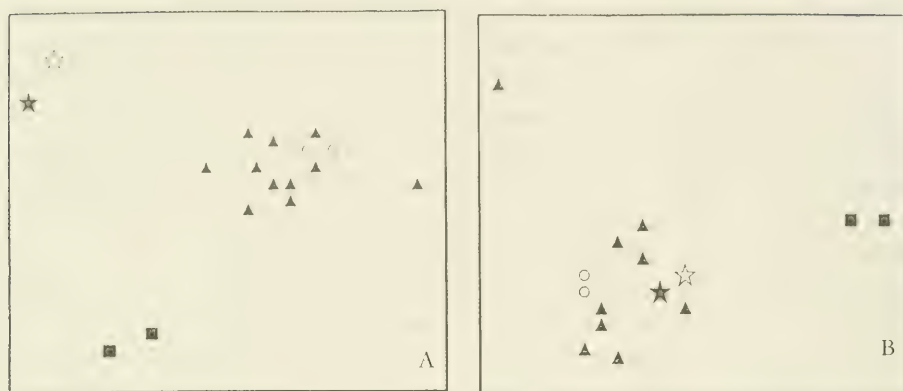


FIGURE 14. Principal coordinates ordination of New World samples using R matrix data from a Relethford-Blangero analysis of 14 variables. A shows the distance between any two points reflects their differences if all samples were considered equal in size and rate of expansion. B reflects differences between samples when North and South American population sizes are estimated as 0.3 of the size of other populations. North American Paleoindians (solid stars), South American Paleoindians (open stars), more recent American Indians (solid triangles), Pacific Northwest Indians (open circles), and Eskimos (solid squares). (After Powell and Neves 1999.)

samples. The Eskimo sample remains distinct since its population size was not adjusted in Figure 14B. Assuming that these relative estimates of variance reflect the balance between genetic drift and gene flow acting on a population, then Figure 14B indicates that the distinctiveness of the Paleoindians could have been achieved through genetic drift, rather than assuming that the Paleoindians represent a different founding population. Figure 14A however, indicates that some other cause is creating the extent of variance from the average of the populations, plausibly that Paleoindians, like the Eskimo, were derived from a different founding event.

Conclusions

In reviewing the past decade of research on the skeletal remains of the earliest known inhabitants of the New World, we feel confident that the early American Holocene samples are distinguishable from the late Holocene and extant American Indians. It has also been documented that the South American and North American Paleoindian samples look more like one another than either does to living American Indians, yet they differ to a lesser degree among themselves as well. And research has documented that these earliest remains more closely resemble mid-Holocene remains than they do late Holocene remains. While all of these conclusions have been based on

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very small and incomplete samples, the consistent pattern in the way the early Holocene remains differ from more recent populations gives us confidence that these differences are real and not a result of sampling error. Achieving this level of knowledge about the First Americans has been an achievement.

What has remained more equivocal, however, is an understanding of the cause or causes of this variance. The two basic competing explanations for the causes of the variation are, that the distinctions reflect different ancestry, or that the distinctions are the result of genetic drift and subsequent gene flow within and between populations once they arrived in the New World. Both explanations have ardent supporters, and both have evidence to support their arguments. It is also true that there are weaknesses in both arguments.

Even we, who have collaborated over a period of 10 years in our research on the topic, do not envision the same history and process for the peopling of the Americas. We do, however, agree on the broad outline of the events. We agree that the evidence does support the view that the Paleoindians were structurally distinct from most recent American Indian populations. One of us (DGS) believes that the features of the earliest remains generally reflects the features of their Old World ancestors, either a more generalized Northeast Asian population prior to the development of the recent Northeast Asian features; or a more central or southern Asia population, one similar to the Jomon of Japan. Both authors accept the evidence of the similarity of the Paleoindians and the mid-Holocene samples as evidence that these early Holocene peoples contributed at least some of their genes to mid-Holocene populations, and plausibly to some more recent North and South American Indians as well.

When we look from the perspective of today's and Late Prehistoric American Indian populations and look back through time, one (DGS) of us sees evidence of more recent Northeast Asian colonists adding their genes to the pool that will become the North American Indians of today. The other author (JFP) sees that as a possibility as well, but also sees the possibility that much of the more recent American Indian features are the result of genetic drift and gene flow shaping the first founding population to be the North American Indians of historic and present times. What is most apparent to us both, however, is that while we and other scholars have documented the craniofacial differences between the earliest known Americans and Late Prehistoric and present day American Indian populations, the processes that have created these differences have yet to be unequivocally revealed.

Abstract

The oldest human skeletal remains found in North America share broad similarities with northern Asians, Southeast Asians, Pacific Islanders, and recent Native Americans. Among these populations North America's earliest remains resemble more closely South East Asians and some Pacific Island populations than they do northern Asians and Native Americans. The modest but consistently documented differences between the early North American remains and recent North American Indians has challenged our traditional view that the Americas were colonized by Northeast Asians in a time too recent for evolutionary forces to have altered the features of their Native American descendants. While the differences between the earliest and more recent skeletal remains have become well documented, identifying the evolutionary force or forces which created these differences is more equivocal.

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CHAPTER SIX

TEETH, NEEDLES, DOGS, AND SIBERIA: BIOARCHAEOLOGICAL EVIDENCE FOR THE COLONIZATION OF THE NEW WORLD

Christy G. Turner II



There are many improbable and unscientific views dealing with the origins and peopling of the New World, such as autochthonous creation (numerous Native American religious traditions), lost Israelites (Mormonism), and unbelievable claims such as space alien colonization. On the other hand, there are hundreds of thoughtful, empirically-based or theoretically-oriented scholarly contributions to understanding the colonization of the New World. These fall readily into two classes of temporal viewpoints, Clovis first or pre-Clovis. (Bonnichsen & Turnmire 1991; Dillehay 1999; Dillehay & Meltzer 1991; Hall 2000). There are one major and two minor schools of thought on origins and routes: Most likely Beringian, much less likely trans-Pacific or trans-Atlantic, and impossibly autochthonous. There is a fairly unrancorous set of ideas on the number of migrations, basically one to four (Gibbons 1996), with much, much later arrivals starting around A.D. 1000 with the Vikings whose arrival from Europe via Greenland depended on large sailing boats (Boorstin 1983). There is a generally coherent group of findings on Beringian paleoenvironmental conditions, resources, hazards, and opportunities: Arctic steppe with patchy Beringian resources, but megafauna present (Guthrie 1990); mountain forest-steppe and steppe (Laukin 2000); and coastal maritime (Laughlin & Harper 1988). Finally, there is a small but challenging class of ideas concerned with learning why the colonization of northern Siberia and Beringia ever occurred in the first place, and why it seems from most archaeological evidence to have been so late in the Pleistocene history of human dispersal (Fagan 1990; Soffer 1990; Yesner 1998).

Each of these major and minor domains, be they based on diachronic or synchronic evaluations, or both, has been championed by workers using primarily a single line of evidence. For example, nuclear or mitochondrial DNA (Szathmary 1993); Y chromosomes (Hammer *et al.* 1999); diachronic studies on crania (Powell & Neves 1999), dental morphology (Turner 1992a), and stone tools (Dillehay & Meltzer 1991). All try to assess Old World origins and affinities: timing, derived from dates of early archaeological sites

or typological correlations; language classification for number of migrations; and so forth. However, integrating diverse evidence, in the growing tradition of modern evolutionary studies, requires that all or most of the domains of evidence be weighed and considered together, if not by individuals, then by teams of specialists (Bonnichsen & Steele 1994).

Operationally, holistic endeavors utilize at least two scientific principles of evidence evaluation — parsimony and concordance. The best single hypothesis will be the one that integrates the most information (holistic), with the fewest number of assumptions (parsimony), and where several lines of evidence lead to the same or similar inferences (concordance). In addition, the quality and types of evidence should meet reasonable standards of robusticity, redundancy, independence, and consensus. Reality, ultimately, is that which we agree it is.

On the other hand, as in all areas of scientific investigation, there can be curious evidence that fails to fit any existing or imaginative pattern, yet seems intuitively to have merit. For example, with respect to the later peopling and cultural evolution in the Americas, the possibility of small numbers of trans-Pacific migrants such as rare Chinese or Jomon boating events refuses to go away (Meggers 1971). At the present time, in my long-standing view, three Late Pleistocene migration events of presumably already bioculturally differentiated stocks can be inferred from a multidisciplinary data base: early Beringian interior Paleo-Indians (called variously Clovis, “epi-Clovis,” Macro-Indian, Chinese-Siberian microlithic), later interior Beringian Paleo-Arctic people (Greater Northwest Coast, Na-Dene, Diuktai), and south Beringian coastal proto-Aleut-Eskimos (lower Amur, Hokkaido). I introduce the term epi-Clovis in recognition that the hallmark object in Clovis identification, the fluted spear point, had probably not been fully developed in the first bands to reach Alaska (such as Component I at Dry Creek, often referred to as the Nenana Complex (Hoffecker *et al.* 1993); however, other corresponding stone tool types are present in Clovis and the Alaskan epi-Clovis (Hoffecker *et al.* 1993:51). Similar tool types are known for the Chinese microlithic tradition that is strongly like the widespread Northeast Siberian Diuktai and Alaskan Paleo-Arctic traditions, both of which are viewed by Russian archaeologists as derived from north China. With these introductory remarks and suggestions of my own inferential preferences, let us look at what I consider to be the eight major questions that, viewed together, provide a broad multidisciplinary working hypothesis for the human colonization of the Americas.

Where Was the Regional Ancestral Homeland(s)?

Aside from the obvious geographic proximity of Alaska and Siberia, which has long suggested the proximate homeland of ancestral Native Americans, there are other lines of evidence that can be brought to bear on the question. One of these is dental morphology that has been used for more than a century to characterize and classify mammalian species, assess intergroup genetic relationships, and trace migrations. With respect to the peopling of the New World, Hrdlicka (1920) was among the first to propose an Asian homeland for ancestral Native Americans employing dental morphology, especially the shovel-shape polymorphism of the upper incisors. Shovelings is very common in all Native Americans and Northeast Asians but is much less common, to very rare, elsewhere in subfossil and modern world populations. Subsequent studies by Pedersen (1949), Moorrees (1957), K. Hanihara (1968), Zubov and Khaldeeva (1979), T. Hanihara (1991), Turner (1991, 1992a, 1994b), Scott (1994), and many others, have added to the dental evidence pointing to an Asian origin for all Native Americans. At a conference held in Khabarovsk, U.S.S.R. in 1979 I proposed that East Asia contained two geographic variants of the "Mongoloid dental complex" defined by K. Hanihara (1968). These were a Southeast Asian pattern of retained and simplified features I called Sundadonty, and in Northeast Asia the morphological pattern was more specialized and complex. This latter pattern I called Sinodonty (Turner 1983, 1987, 1990a). I have found only Sinodonty in prehistoric New World teeth. Figures 1–3 show examples of dental morphology used in local, regional, continental, and intercontinental comparisons that define Sinodonty and Sundadonty. Figure 4 shows in synoptic multivariate fashion that all Native Americans, ancient and recent, are more like one another than like Ainu-Jomonese, recent Japanese and Chinese, Polynesians, and Europeans. The close dental relationship between the 9000 year-old Archaic period Spirit Cave and Wizards Beach crania of Nevada, and recent Paiute Indians of Nevada indicates dental continuity through time. Figure 5 shows that the dental relationship in the Americas lies with peoples of the American Arctic, Northeast Asia, and Neolithic Southeast Asia (a result of migration southward of northerly agricultural Sinodonts). There are no close relationships with modern Southeast Asia (Thailand), Europe, Oceania, or Africa. Like many other studies of teeth and crania, Australians and Africans are closely linked but show no relationship to Native Americans. Hence, on the basis of dental morphological comparisons, the homeland of Native Americans continues to be best viewed as having been in Northeast Asia. To test this hypothesis requires demonstrating that only Northeast Asia was the Pleistocene homeland of the Sinodont dental pattern. To date, Sinodonty has not been found in any non-Asian skeletal assemblage regardless of geological time

(Zubov & Khaldeeva 1979; Grine 1981; Turner & Markowitz 1990; Roller 1992, Irish 1993; Haeussler 1996; Lipschultz 1996; Hawkey 1998; Adler 1999; and many others). Turner and colleagues (2000) restudied the dental features retained in plaster casts of the north China Zhoukoudian Upper Cave human crania (the original skulls have been lost). We concluded that the Sinodont morphological pattern was present, and depending on the age of the Zhoukoudian remains (dates range from 11,000 yr B.P. to 30,000 yr B.P.), the ancestors of Native Americans were Northeast Asian Sinodonts, who, in turn, had evolved from Sundadont or Proto-Sundadont stock that earlier began in Southeast Asia or Australasia (Turner 1992c; Hawkey 1998).

In addition to many synchronic anthroposcopic and anthropometric comparative studies of living Native Americans and other worldwide populations that show strong affinity between North Americans and Northeast Asians, there have been numerous similar but diachronic osteological investigations into Native American anatomy and its bearing on origin questions. Most of the osteological studies have been carried out on cranial measurements such as head shape (Howells 1995; Steele & Powell 1992), or on nonmetric features such as sutural patterning of the skull (Kozintsev 1988) and other traits (Ishida 1993; Ossenbreg 1994). Most comparative cranial studies closely link Native Americans with Northeast Asians, but a few analyses have been interpreted as suggesting morphological if not genetic affinity of Archaic New World crania with Australia and Africa (Lahr 1995; Neves *et al.* 1999) and Ainu (Powell & Rose 1999). Such scattered and unpatterned results do not fit the larger phenetic and cladistic pattern seen in anthroposcopic, genetic, and dental morphology studies. These anomalous craniological findings may be due to error arising from small sample size, unknown environmental effects on crania (such as the rapid secular change in head form in many parts of the world), and dietary and mastication effects on facial architecture and jaw shapes, etc. It is noteworthy that with the introduction of maize agriculture and pottery from Mexico, the crania of prehistoric Southwestern U.S. Pueblo Indians became less robust (Hrdlicka 1931). In my view, this Puebloan cranial change was not determined genetically as it could have been if caused by migration from Mexico, rather it more likely was related to the softening effects of foodstuffs cooked in pots. This softening reduced the need for the heavy food chewing stress that contributed to cranial robusticity, just as muscular activity affects other areas of the skeleton. Moreover these stews and gruels seem to have contributed significantly to rampant and painful dental caries, even in children, leading to even less chewing or biteforce applied to the jaws and face of children and adults alike. There are numerous other examples in the New World of shifts in food preparation techniques, even beginning in Archaic times, that could have affected cranial form.

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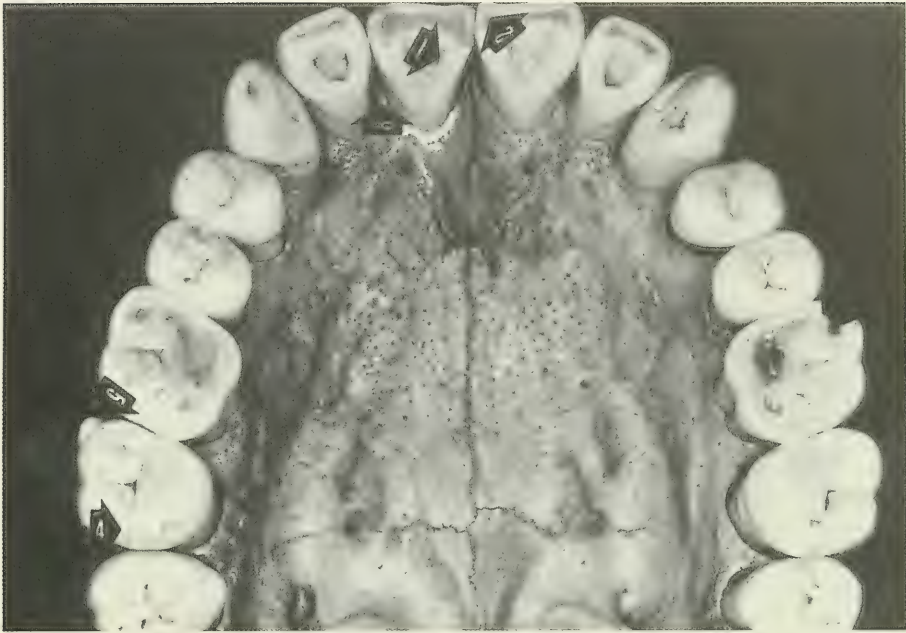


FIGURE 1. Illustrated in these upper teeth are (1) the marked expression of incisor shoveling on the lingual surface, (2) double shoveling on the central incisors' labial surface, (3) the similarity in size of the central and lateral incisors, (4) the near absence of the hypocone on the second molars, and (5) the presence of a parastyle on the second molar, a rare feature. This individual was a relatively young male of the preceramic Basketmaker culture. He died before A.D. 400 (late Archaic period). The skeleton, excavated by R. Wetherill from Cave 7, southeast Utah, has a dentition much like all other ancient, recent, and unadmixed living North and South American Indians and all known populations of north-eastern Siberia and Primoria. These dental characteristics, among others, define the Sinodont division of the Mongoloid dental complex. Unlike ancient and modern Europeans, where shoveling is rare, lateral incisors are relative small, etc., Sinodontology is characterized by trait intensification and specialization. European teeth are characterized by simplification and reduction (CGT neg. 6-26-78:16 Am. Mus. Nat. Hist. 99/7371).

While large sample intergroup comparisons of dental and cranial morphology usually show strong correspondences (Hanihara 1991), smaller samples have led to very unexpected findings. For example, the previously mentioned three Zhoukoudian Upper Cave crania, when studied individually (Brown 1998; Kaminga & Wright 1988), instead of as a group, have led these researchers to see non- or semi-Mongoloid resemblances.

In the realm of archaeological research, most of the cultural evidence recovered in the Americas has been in the form of artifacts made of stone, the typologies of which



FIGURE 2. The middle tooth in these five upper left teeth is the first premolar with the morphological crown shape that D.H. Morris called "Uto-Aztecan premolar." The morphology differs strongly from the second premolar (second tooth on the left in this view), which is the normal form. Subsequent to Morris's study, other workers and I have looked for the trait throughout the Americas. It has never been found in Aleut-Eskimos or Indians in the Na-Dene area. It is believed to be due to a mutation carried to the New World only by Paleo-Indians, one of the facts which I feel indicates that the three New World dental groups had differentiated in Siberia before crossing Beringia. The Uto-Aztecan premolar has never been found in Europeans. The pictured individual was a young female who lived sometime before A.D. 1700. She was excavated by J.W. Fewkes from Awatovi, northeastern Arizona (CGT neg. 6-10-78:16 Nat. Mus. Nat. Hist 156324).

indicate a northern Eurasian homeland, but with no clear-cut regional sourcing identifiable so far (Mochanov 1977; Derev'anko 1990; Vasil'ev 1996; Dikov 1997). Blade tools, bifaces, burins, adzes, spurred scrapers, chipping methods, and other technological features are more common in early New World sites than are the less formalized tools of Southeast Asia, Australmelanesia, and the late Mousterian industries of Europe and southern Siberia. Late Pleistocene unifacial blade tools occur in the Amur River basin and on Hokkaido that match well with the earliest stone artifact types found in the Aleutian Islands. Throughout much of Late Pleistocene Northeast Siberia, Russian archaeologists have recovered microblades and bifacial tools together, an assemblage

TEETH, NEEDLES, DOGS, AND SIBERIA

usually referred to as the Diuktai culture (Mochanov 1977; Dikov 1997). This distinctive combination matches assemblages called Paleo-Arctic in interior Alaska (Dumond 1987) and British Columbia (Carlson & Bona 1996). Hence, stone tool assemblages point to at least two cultural homelands for ancestral Native American cultures — Amur-Hokkaido, and Primoria-Yakutia-Chukotka. However, so far only one fluted point has been recovered in northeast Siberia (by archaeologists M.L. King & S.B. Slobodin) in good stratigraphic context, but it is not old enough to be considered ancestral to Clovis. In fact, there is presently lacking any exactly corresponding Siberian assemblage like that well established for Clovis, whose hallmark is the fluted point, or the early assemblages of Alaska-like Component I of Dry Creek (Hoffecker *et al.* 1993). For this reason, Stanford 1999, this symposium) argues for a European origin for Clovis on the grounds that Solutrean spear points are more similar to Clovis than anything known for Siberia, north China, or Japan. This suggestion has not been well received on both temporal and tech-

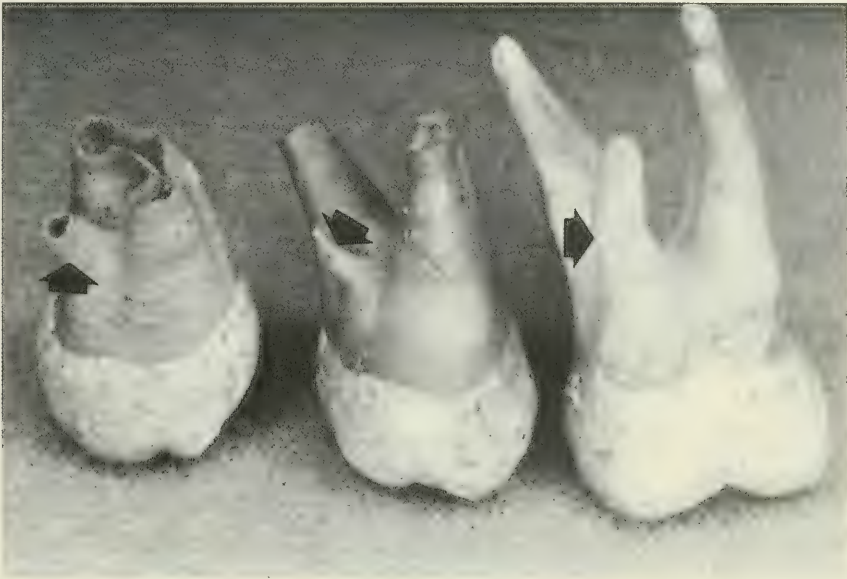


FIGURE 3. Root form and number is also involved in the definition of human dental patterns, although inheritance is less well understood than is crown morphology. Pictured are right lower molars with distolingual supernumerary roots (arrows) that are rare in ancient and modern Europeans, but present commonly to frequently in northeast Asians. In the New World, Aleut-Eskimos have the highest frequency of this trait (*ca.* 30–40%); Northern Northwest Coast, intermediate (*ca.* 15%); all other Indians in North and South America about the same (*ca.* 5.0%). Again, this hemispheric variation is viewed as evidence of three migrations. Pictured is a Shang Dynasty subadult from An-yang, China (CGT neg. 9–5–75:36 [color] 122 Academia Sinica, Taipei).

nological grounds (Straus 2000; G.A. Clark, personal communication, January 4, 2001). That there may have been occupation of the New World before Clovis, that is, before 11,500 yr B.P. continues to be a hotly debated subject (West 1996; Hall 2000; Roosevelt *et al.*, this volume; Meltzer, this volume).

Many Native American cultures have oral traditions that envision their ancestors as having originated in the New World (Echo-Hawk 2000). There are many well known origin legends involving migrations, such as among the Hopi and Navajo, but these are of much less historical value than they are for cultural patrimony. Despite the lack of historic specificity, there are oral traditions of heroic shamans and their spirit-helpers, which when combined with ethnographic features such as the round flat shaman's drum found throughout Siberia and the Americas, points to a north Eurasian homeland for all Native Americans.

In sum, the ultimate regional homeland can reasonably be hypothesized as having been in north China, Mongolia, and southern Siberia, a rich ecologically diverse region occupied long before humans set foot further north. An easy to remember focal point of this region is Lake Baikal, near the headwaters of the Anadar, Ob, Yenisei, Lena, and Amur rivers that together drain much of central and eastern Siberia.

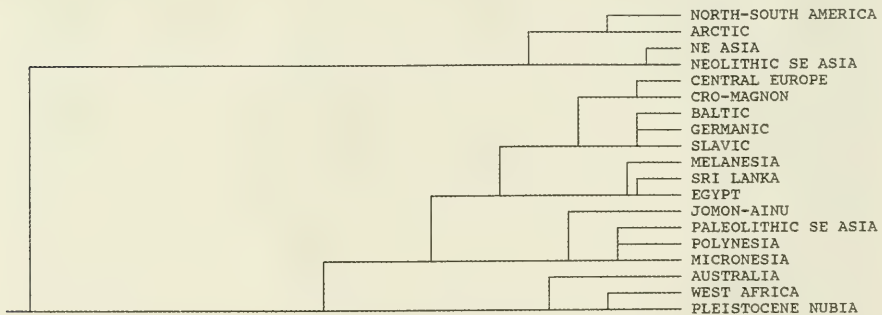


FIGURE 4. Dendrogram of worldwide dental relationships based on the multivariate Mean Measure of Divergence statistic clustered with Ward's method involving 25 crown and root traits belonging to 1000s of individuals. As discussed in the text, the dendrogram shows a strong similarity between dentitions of the New World and those of Northeast Asia. There is no close relationship between Native Americans and Europeans or Jomon-Ainu (Computer file reference: Small World-94, 19 groups without central Asians).

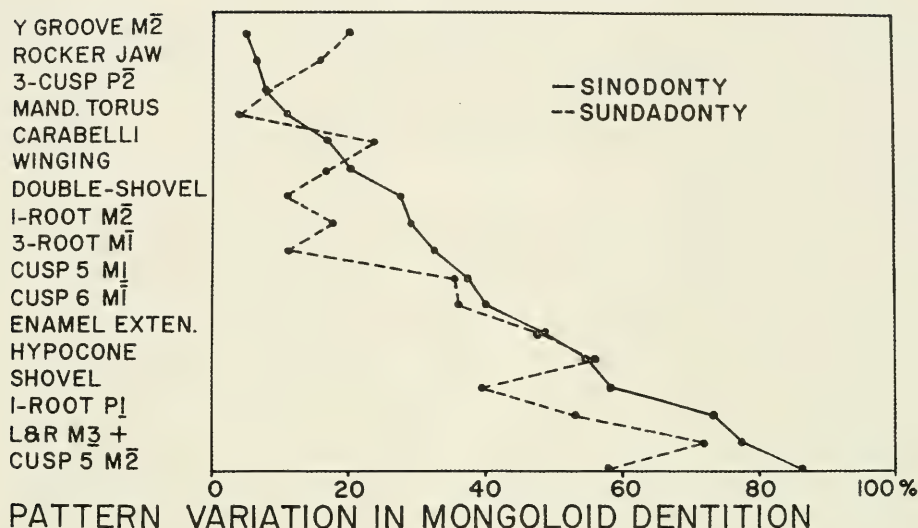


FIGURE 5. Shown are some of the dental traits and their frequencies used to define Sundadonty and Sinodonty. The former is a dental pattern characterized by retention and simplification, the latter by intensification and specialization. For example incisor shoveling is more frequent and more pronounced in Sinodonts (intensification), less so than in Sundadonts (retention). As individuals age, their dental crowns wear out and their roots can acquire excessive cementum, both age-related conditions can contribute to under-scoring of features such as shoveling, cusp and root numbers, and other traits.

What Was the Route(s) to the New World?

Most lines of evidence point to a Bering land bridge route for the initial colonizers of the New World. Some of this evidence has been touched on in the homeland consideration. It is not all of equal value. However, the pattern and its independent corroboration is clear and strong. Seemingly, some workers who favor a pre-Clovis settlement of the Americas are trying to get around the lack of evidence for a pre-Clovis occupation of Northeast Siberia and Alaska by seeking other routes or means of entry. A Pacific coast boating scenario was proposed years ago by Fladmark (1978) that would have left little or no pre-Clovis evidence anywhere due to the 100 m rise in sea level at the end of the Pleistocene. A similar suggestion, based on a typological similarity between Clovis and Solutrean points, for a trans-Atlantic route (Stanford 1999) would likewise have left no evidence if the southern edge of the Atlantic pack ice was followed into North America as he suggests. And suggestions for a trans-Pacific route from Australia has the

same problem of not being disprovable due to the flooding of the continental shelf of South America where landings might have taken place. Lacking independent corroboration or conformity with the generally agreed upon Bering land bridge hypothesis, claimants need to not only pursue their claim by showing how the prevailing Beringian hypothesis is wrong, but also develop the means of falsifying their own alternative proposals.

The Bering land bridge route could have involved not only an interior crossing, but also a south coastal drift or both. There could also have been relatively early and later transits as well, and these could have been more-or-less discrete movements, or a more drawn-out and semi-continuous flow of people (Turner 1985; Scott 1991). The preponderance of evidence points to a Bering land bridge route for the initial colonization of the Americas. On the other hand, at least two thorny problems are evident: First, defining archaeologically and biologically what is meant by "migration" has not met with much success. While there is a large body of sociological and demographic facts and theory on migration, it has not been well reviewed by workers interested in the peopling of the Americas. Second, while it is reasonable to equate cultural variation with biological variation in early small isolated groups, such is not always the case. Because there are almost no Pleistocene human remains from archaeological sites in far Northeast Siberia (N.N. Dikov provided me with photographs of a few deciduous but racially indiscriminate teeth he found at Ushki on the Kamchatka Peninsula), and none in Alaska, we are left with mainly stone tool variation and site distribution patterns as hints of biological populations. There may well have been very little genetic variation in the waves of migrants to Alaska, even though there is substantial geocultural variation, that is, early in the settlement of Alaska alone, three traditions can be recognized. At Dry Creek, near Fairbanks, the earliest horizon, Component I (*ca.* 11,000 yr B.P.), has blades and bifaces but no microblades; Component II (*ca.* 10,500 yr B.P.) has microblades in addition to blades and bifaces (Powers & Hoffecker 1989; Hoffecker *et al.* 1993). In the Aleutians, at Anangula (*ca.* 8,500 yr B.P.), there are no bifaces, only unifacial blade tools ranging in size from micro- to macroblades (Laughlin 1980).

When Was the Time of Arrival?

To date, no archaeological sites have been found in Alaska that are older than 12,000 yr B.P. (Hoffecker *et al.* 1993), although there are controversial claims for earlier sites further south such as Meadowcroft in Pennsylvania and Monte Verde in Chile (reviewed in Meltzer [1993] and in nearly every issue of *Mammoth Trumpet*). Much has been written by Russian scholars about the ancient, historic, and modern peoples of Siberia and their

regionally variable environment and climate (see reviews or translations written in English or French in Derev'yanko 1990; Haeussler 1996; Levin & Potapov 1964; Malet 1998; West 1996). As a generalization, climate is much more stable, less severe, and archaeological sites are much earlier and more abundant in southern Siberia than in the far north. In the Altai Mountains west of Lake Baikal and north of Mongolia, for example, there are later Pleistocene sites such as Kaminnaya, Ust-Kan, Denisova and Okladnikov caves with rich deposits of Mousterian stone artifact types and occupation debris that have been dated to at least 30,000 years ago. One thermoluminescence date for a deep layer containing Mousterian stone artifacts at Denisova Cave is 151,000 to 170,000 yr B.P. (M. Shunkov, personal communication, July 14, 1999). The oldest 14 C date for humans in Kamchatka was obtained at Ushki, being about 14,000 yr B.P. (Hoffecker *et al.* 1993). The 10,260–13,700 year-old Berelekh site is one of the very few generally accepted Siberian sites north of the Arctic Circle (Sinitsyn & Praslov 1997; Kuzmin 1997, 2000). Since no assemblage of Mousterian stone artifact types have been found in Siberia near the Arctic Circle or in any New World site, it would appear that far northern Siberia was uninhabitable until sometime around 15,000 years ago. This is the time when the world's climate began to warm up rapidly, causing continental ice masses to melt, sea levels to rise, vegetation zones to shift or go extinct, associated animals to go extinct, and other drastic environmental changes throughout Beringia and most other regions of the world (Martin & Klein 1984). The far northern Siberian and Alaska Arctic steppe habitat of dry cold-adapted grasses, sage brush and other shrubby flora ceased as did nearly all the megafauna this habitat supported. Thick forest taiga and treeless boggy tundra replaced the Arctic steppe, with a resulting reduction in large herbivore and carnivore biomass, and the formation of vast hummocky plains difficult to walk or sled across.

One of the many interesting taphonomic findings my Russian co-workers Nicolai Ovodov, Olga Pavlova, Nicolai Martynovich, and I made in the past three summers (1998–2000), was that of all the several thousands of food refuse bone fragments we examined from several Late Pleistocene sites in the Altai and Lake Baikal regions, we identified very few clear-cut examples of burned bone. Said another way, while we identified many excellent examples of stone tool butchering marks and perimortem marrow-exposing bone breakage, we found extremely little taphonomic evidence of cooking. Moreover, these limestone caves with their marvelous qualities for preservation have produced only tiny residues of charcoal, despite paleoenvironmental reconstructions based on small and large rodents, such as beaver, that indicate there was forest on the ancient landscape that would have been available for firewood. Is it possible that the more northern reaches of eastern Siberia were unreachable because these Late

Pleistocene Mousterians made only limited use of fire? While it is likely that they made fires for cooking, warmth, and repelling insects, it is not well documented thus far in their refuse. My point regarding fire is simply this: Those ethnographic and technical features that characterize native populations north of the Arctic Circle at historic contact, are not readily apparent in the Mousterian horizons of southern Siberia, whereas they are present in the region's Upper Paleolithic strata in both cave (Kaminnaya, Ust-Kan, Denisova, etc.) and open sites (Mal'ta, Kurla I, Gosiderev Log-1, etc.). One reasonable inference of these preliminary taphonomic findings is that the far north was uninhabitable by humans until certain developments in technology had come about.

We also determined from taphonomic analysis of animal bone damage and numerous well-preserved coprolites that humans were not the sole residents of these Altai and Khakatian caves. At various times they were inhabited instead by hyenas and other carnivores. In addition to the cold and patchy northern zone of Siberia, roving packs of hyenas might have been another factor in the failure of the Siberian Paleolithic Mousterian folk to reach the Arctic Circle. The hyenas may have, not only scavenged the remains of Mousterian kill sites, with various negative implications for the duration of human encampment at a given kill site, but these large nocturnal social carnivores may also have preyed on the Mousterians or their children, especially those bands with low population density along the northern periphery of their Siberian distribution. Other carnivores that Ovodov has identified in many archaeological and paleontological cave deposits include lions, tigers, bears, wolves, and various other smaller meat-eaters.

In sum, my growing knowledge of Siberian prehistory based on studying published archaeological reports, our various site visits in the Ob, Yenisei, and Angara River basins and related travel, study of artifact, faunal, and human skeletal collections from these and other areas, and some excavation, continues to suggest that there was a very severe environmental barrier to humans reaching western Beringia until almost the end of the Pleistocene. To date, I have found no solid evidence for human occupation north of the Arctic Circle before 15,000 yr B.P. This is far shorter than suggestions of 30,000 or more years of New World occupation proposed by some archaeologists and geneticists. One of the leading pioneers of Bering land bridge research is David M. Hopkins. Once an emphatic proponent of a pre-Clovis Beringian crossing, Hopkins (1996) now feels that the Alaskan and Siberian evidence for pre-Clovis is weak or non-existent. Keeping in mind this authoritative shift in opinion, let us turn to the question of migration number.

How Many Migrations Were There?

Estimates of the number of migrations range from one (Laughlin & Harper 1988), to hundreds (Voegelin 1958). Most workers in archaeology, linguistics, physical anthropology, and more recently, genetics, favor a few migrations rather than many. There is not a great deal of difference in one, two, three, or four migrations when one recalls that defining the term migration is far from operationally precise, and when one recalls that the archaeological, linguistic, physical anthropological, and genetic variation in the New World is far less than that of East Asia, despite the New World being a much larger geographic area. Much of the archaeological and paleoenvironmental evidence on this topic is reviewed by several scholars in West (1996), and paleobiological evidence is discussed in Steele and Powell (1992; this volume). Genetic evidence is covered in Szathmáry's (1993) synthesis and Zegura's (1999) insightful book review. However, I would like to go over in some depth the dental evidence because that is what I know best, and it has the useful quality of being able to directly characterize living, recent, and subfossil populations.

K. Hanihara (1968) defined the "Mongoloid dental complex" (MDC) using a few but powerful dental traits, including incisor shoveling, molar cusp numbers, and so forth (Figures 1–3). In the course of my dental anthropological studies of peoples of the Pacific Basin and adjoining areas, I recognized that the east Asian MDC could be divided into southeastern and northeastern groups. These I called Sundadonty for Southeast Asia and Sinodonty for Northeast Asia and all the Americas. Dental morphological comparisons between Eurasian, Pacific, African, and New World populations confirm the long-held view that the initial colonists to reach the New World came from northeast Siberia (Figure 4). All migration waves, whatever the number and migration type, were by Sinodont peoples (In Figure 4 these are North-South America, Arctic, NE Asia, and Neolithic SE Asia). These people may have not been craniologically "Mongoloid" in the typological sense, but they were Sinodonts in the sense of intra- and intergroup odontological variation. In my view, there is no dental evidence in support of any other route or ancestral population. All my analyses of prehistoric and living Native Americans and comparative samples (>25,000 individuals) indicate they possess the Sinodont dental pattern, which is found only in Northeast Asia and the entire New World. On the other hand, Powell and Rose (1999) propose that the controversial Kennewick Man, initially claimed to be a Caucasoid, had a Sundadont dentition. However, these workers have not yet indicated which dental traits they used to reach this conclusion, nor have they indicated how they handled the problem of dental wear. With advanced wear, Sinodonty can be mistaken for Sundadonty. This can be appreciated in Figure 5, which shows fre-

quencies for several traits in Sinodonts and Sundadonts. With wear, traits that vary in degree of expression, such as marked incisor shoveling and frequent molar cusp numbers in Sinodonts can be misidentified for less marked expressions more common in the Sundadont pattern (Burnett *et al.* 1998). Even traits such as root number can be confused in older individuals when cement accretion has been excessive. Chatters (2000) has also called Kennewick a Sundadont, but his assessment can be evaluated since Chatters listed the six dental traits he used to reach this conclusion. Only three of his traits are part of the eight trait suite I originally proposed for differentiating between Sinodontology and Sundadontology (Turner 1990a). On this small basis, I personally would not have drawn any conclusion about dental affinity, even though the traits Chatters used for affinity assessment are not usually affected by wear.

Claims made for European, Southeast or South Asian, Central Asian, Oceanian, early Japan, or African origin for Native Americans can be rejected outright on the basis of all presently known dental descriptions from these areas that are closely calibrated through the use of the Arizona State University Dental Anthropology System (ASU DAS) (Turner *et al.* 1991). A few examples of highly calibrated regional dental anthropology studies include: Europe (Zubov & Khaldeeva 1979, Russians; Lipschultz 1996, Mediterranean; Adler 1999, Finns); Asia (Liu 1998, China; Haeussler 1985, 1996, 1999, Siberia and central Asia; Haeussler & Turner 1992, central Asia and New World); (T. Hanihara 1991, East Asia and Pacific); South Asia (Hawkey 1998, India & Sri Lanka); Oceania (Harris 1977, Melanesia; Weets 1996, Melanesia); Africa (Irish 1993, Africa; Irish & Turner 1990, north Africa; Turner & Markowitz 1990, north and west Africa); New World (Morris 1965, Southwest U.S.; Richert 1999, east Canada; G. Scott 1973, Euroamericans and Southwest Indians; Larson 1978, Southwest U.S.; Nichol 1990, Pima; Crespo 1994, Puerto Rico; Lincoln-Babb 1999, Yaqui, Mexico); Worldwide (Turner 1990b, 1991, 1992a, 1992b, 1992c, 1992d, 1994a, 1994b, 1995, 1998; Scott & Turner 1997; Turner & Hawkey 1991, 1998; Bailey-Schmidt 1995; E. Scott 1998). In addition, strong concordances have been made between the many crown morphology studies of living groups made by Russian dental anthropologists using the Zubov system throughout the former U.S.S.R. and expectations based on ASU DAS.

Inasmuch as most of my dental anthropological and bioarchaeological studies on the peopling of the Americas and the Pacific Rim and Basin are based largely and directly on many samples of dental crown and root morphology of past human populations, aided by the aforementioned students and coworkers, I will first discuss my past and new views on the colonization based on teeth. Figures 1–3 illustrate some of the crown and root traits that ASU DAS uses in a highly standardized observation schedule. My Asian, Pacific and New World studies have identified two major dental patterns as previously

mentioned. Sundadonty is a generalized, retained, and simplified dental pattern that occurs throughout Southeast Asia, Polynesia, Micronesia, and in the Jomon-Ainu people of Japan (Figure 5). Sinodonty occurs in all pre-Cossack Northeast Asians (Chinese, Mongols, Buriats, Siberian Eskimos, the Yayoi-modern Japanese peoples, and others), and all Native Americans. There are slight regional differences in both of these two broad categories, and of course, there are minor temporal differences due to local microevolutionary and biohistoric events. Something like Sundadonty, which I call Proto-Sundadonty, is presumed to be the ancestral condition for the Australian and possibly the similar Melanesian dental pattern. While neither of the two Asian dental patterns looks like that of Europeans, Sundadonty is more like the European dental pattern than is Sinodonty. In fact, Sundadonty is the most generalized dental pattern in the world, showing none of the extremes in trait frequencies as elsewhere (Africa, very high frequency of lower molar cusp 7; Europe, almost no incisor shoveling or 3-rooted lower first molar; Northeast Asia and the New World, very high frequency of shoveling and lower molar cusp 5, etc.). Sinodonty is at least 8,000 years old on the basis of early Holocene teeth belonging to a skull called Shilka found east of Lake Baikal near the city of Chita, teeth of early New World Indians of at least 9,000 years ago, and the three crania from Upper Cave, which may be as old as 30,000 yr B.P. Sundadonty can be postulated as being as old as 20,000 yr B.P. based on the Minatogawa crania from Okinawa, 40,000 years old based on the Niah Cave maxilla found in the Philippines, and perhaps 50,000 years old based on recent Australian Aborigine teeth which, when averaged for the continent as a whole, probably approximate the hypothetical Proto-Sundadont condition (Turner 1992c, 1992d). Hence, there is no dental evidence that Paleo-Indians or any subsequent migrations originated from any dental gene pool other than Northeast Asia, which also includes the far eastern region that Russians refer to as Primoria ("near the ocean") and is not considered by them as part of Siberia (Nazdratenko 1998). However, Primoria might have witnessed an early occupation by Sundadonts as Jomon or Jomon-like artifacts have been found (Popov *et al.* 1997) there as well as in Sakhalin (Vasilievsky 1981).

Sinodont variation in the New World, both past and present, seems to group into three divisions, with some widely separated North and South American samples showing random convergence — useful evidence for thinking that genetic drift is an important factor in dental microevolution. The three New World dental divisions correspond rather well with the three linguistic families defined by Greenberg (1987, 1990, 1996). These he calls Macroindian (Amerind), Na-Dene, and Aleut-Eskimo, as does Ruhlen (1994). Although Greenberg has some detractors, for example, Campbell (1986) and to a lesser degree, Nichols (1998), he has parried with compelling reason that these three

families are genetically real and that they represent three migrations or waves of migrants whose language families had diverged in the Old World prior to their crossing the Bering Land Bridge (Greenberg 1990, 1996). I feel there is as much combined evidence in various archaeological, osteological, dental, genetic, and natural history analyses to argue in favor of the same interpretation, however, some analyses suggest possible admixture event(s) responsible for the formation of the Na-Dene ("Greater Northwest Coast") dental group (Turner 1985; Scott & Turner 1997; Scott 1994). This uncertainty is a continuing area of investigation. Regardless of whether two or three migrations are eventually agreed upon, the colonization of the New World was more likely by a few number of migrants and migration episodes rather than by many migrants and many migration events. I doubt that there was only one migration event as Laughlin first proposed in a 1985 Arizona State University seminar, simply because there is too much linguistic, archaeological, osteological and dental variation in Alaska alone, that in some instances matches that found regionally in Siberia. This view of only a few number of migration events has support in archaeology (West 1996), DNA and blood group studies (Cavalli-Sforza *et al.* 1994), dentition (Turner 1985 & elsewhere), and at least partly in historic linguistics. As for parsimony and concordance, the most, and best evidence and analyses point to Pleistocene Northeast Asians as having been the ancestral stock of all past and present Native Americans. Advocates of an Australian, Southeast Asian, Jomon-Ainu, or European origin have never included more than one line of evidence, or have failed to consider more parsimonious explanations to explain the nature of their evidence or analysis.

My examinations of the teeth of Late Pleistocene Cro-Magnons of Europe and western Russia (1992a, 1998), similar studies by A. Haeussler (Turner 1996, & elsewhere), and the vast numbers of studies by Zubov and Khaldeeva (1979, & elsewhere) and their Russian co-workers, show without much question the continuity of these Cro-Magnons with later Mesolithic peoples and modern Europeans, be they English, French, Danish, Dutch, Russian, or whatever polity. In no case do these Upper Paleolithic Europeans have dental morphology like ancient or modern Northeast Asians or Native Americans. Moreover, many reports show that several European dental trait frequencies are more like those of Africans than like Sinodonts or Sundadonts (for summary, see Scott & Turner 1997).

Did any Late Pleistocene group other than Sinodonts reach the New World? Cranial analyses of some South American crania have suggested that there might have been an early migration of "Australoids" (summarized in Lahr 1995; Neves *et al.* 1999), or at least a group of early migrants whose crania differed in robustness from those of more recent South American Indians. While these analyses are based on very few crania, and they are

not unambiguous about the American and non-Asian similarities, they do have a few champions who point out that if Australia had been reached from Southeast Asia with the use of watercraft 50,000 years ago, the New World might have been similarly reached, namely by very early boating people. However, the early stone tool technology of Australia and Southeast Asia (horse hoof cores and scrapers, sumatraliths, etc.) have not been found with any of the South American “Australoids,” as would be expected if there had been a Pacific transit 20,000 to 50,000 years ago from Sundaland or Sahulland (Green 1992). Moreover, if this “Australoid” trip was by watercraft from the more northerly end of the Sundadont population distribution, namely the early Jomonese of Japan, then we would expect their distinctive stone tool types to show up instead. As far as I know, such is not the case. While I have not examined every dentition from crania claimed to be pre-Clovis or non-Clovis in South America, all that I have examined, including Archaic collections from Ecuador, Peru, Chile, and Brazil, exhibit only Sinodonty (Turner 1992a).

Based on skull shape, suggestions have been made that early Holocene (9,000 yr B.P., Tuohy and Dansie 1997) crania from Nevada — Spirit Cave and Wizards Beach — are less like Native Americans and more like some Old World populations, possibly Caucasoids or Ainu. While the teeth of these crania are very worn and not much information can be gleaned from them, nevertheless, that which can be safely scored reveal the teeth of these skulls to be very similar to those of recent Native Americans and unlike Ainu or Europeans (Figure 6).

The most controversial proposal for the peopling of the New World comes from Dennis Stanford (1999 and this symposium), who along with stone tool-making expert, Bruce Bradley, envisions a Late Pleistocene “migration” reaching the New World from Spain by traveling along the southern edge of the north Atlantic pack ice. Their north Atlantic pack ice route is grounded in their belief that a “genetic” relationship exists between American Clovis and Iberian Solutrean points, as well as the apparent absence of this type of point manufacturing in Asia during Late Pleistocene times. All known European Late Pleistocene and Holocene dental evidence is unsupportive of this idea, although, admittedly, I know of no dental studies on whatever Solutrean skeletal remains may have been recovered in Spain. Nevertheless, published descriptions and personally-studied dental morphology of French Cro-Magnons, and the excellent descriptions of Late Pleistocene teeth from western North Africa by Irish (1993) are very much like modern Europeans and very dissimilar to Native Americans, ancient and modern. Since Spain lies between France and western North Africa, it is fair to assume that the dental morphology of the Upper Paleolithic Iberians was like that of the adjacent northern and southern populations.

Teeth not only provide a resource for identifying cladistic relationships, they also provide information on environment and tooth-use behaviors. One of the most interesting environmental effects on teeth of humans who lived in the Arctic is the great amount of dental damage due to chipping, breakage, and *ante mortem* loss, which is significantly greater than in sub-Arctic dentitions. Much of this traumatic damage is thought to have been due to near-starvation events where bones were chewed for residual nutrients by children and adults alike, as well as the use of teeth as tools, such as vice grips (Turner & Cadien 1969). Arctic dwellers rarely had dental caries, another environmental effect due to the near absence of cariogenic carbohydrate foodstuffs in their diets. These people ate almost exclusively products derived from mammals, fish, and birds.



FIGURE 6. Dendrogram of representative samples of New World, Asian Sinodonts and Sundadonts, Polynesians, and Europeans. The target population consists of the early Holocene Spirit Cave and Wizard Beach individuals from Nevada. As this analysis shows the teeth of these early Holocene people were most similar to those of recent Indians of Nevada, show no similarity with Ainu or Jomon teeth, and are most dissimilar to the European dental pattern. The analysis shows that all American Indians cluster together (the top major branch), indicative of but one common ancestral population for all North and South American Indians (Computer file reference: Nevada 20 groups—29 traits 1–3–99).

What is the Genetic Affinity Between Native Americans and Peoples of the Old World Including the Pacific Basin?

Most genetic evidence, serological and DNA, points to strong cladistic connections between Native Americans and Northeast Asians (Szathmary 1979, 1985; many other workers). But there are one or two genes that hint synchronically at some ancient or more recent minor relationship with eastern Europe or western Siberia. Neither the Late

Pleistocene archaeology of southern Siberia nor a new mitochondrial DNA study (Voevoda *et al.* 2000) rule out such a possibility. The monumental study by Cavalli-Sforza *et al.* (1994) leaves very little room for doubt that all Native Americans are closely related to Northeast Siberians, making that region the best candidate for the proximate ancestral homeland. Moreover, these workers support the three migration hypothesis based on linguistic and dental morphological inferences, as did Powell (1993).

How Many Migrants Crossed Beringia?

This is a question that one seldom finds workers unfamiliar with evolutionary processes much concerned about. However, population size is a key factor in biological and cultural microevolution. The smaller the population, the greater is the opportunity for rapid genetic change through time due to random chance, even in the context of severe selective pressures as expected under Arctic conditions. It is not unreasonable to suppose that the same evolutionary forces that affect biological change operate also on cultural variation, even if proof of such has yet to be well established. Hence, in the rapid expansion model of P. S. Martin (Martin & Klein 1984) there could have been marked changes in the biocultural characteristics of Siberians as they progressed north and eastward to Alaska, with subsequent rapid dispersal throughout the rest of the New World. There are numerous examples of small founding populations failing to gain a foothold in their newly discovered environments, due presumably to the negative effects of small population size. One obvious demographic effect of small population size is on the size of the breeding population, usually looked upon as about one quarter of the total number of females. In a population of 100, on the average there will be about 50 females, of which there might be only 12 or so women of breeding age. If only a few of these had children who lived to reproductive age themselves, then the chances of there being a representative sample of genes (and to some degree, culture) transmitted to future generations is less than 50 percent. If success breeds success, as it often does, then a rapid train of cultural and genetic change could be expected. One expectation would be a loss of variation.

One of the fascinating characteristics of Clovis culture is its marked uniformity in lithic projectile point style throughout North America. A similar low amount of variability characterizes most of the genetic and dental features of prehistoric and living North and South American Indians. If Greenberg (1987) is correct in his New World language classification, then the limited amount of linguistic variation at the phylum level is also a feature of New World populations. The parsimonious interpretation of this low amount of biocultural variation relative to that of East Asia with its smaller land mass,

much longer period of human occupation, and equally diverse environmental zones, is that the size of the New World founding population was absolutely small. As such it could not possibly have carried a representative sample of the genetic polymorphisms and diverse cultural features of Northeast Asia, let alone all of East Asia. If small founding population size was the case, and I sense that most archaeologists, physical anthropologists, and geneticists interested in the peopling of the New World would concur, then either rapid biocultural changes could be expected in the Beringian transit or there was imperfect representation (or both), which resulted in an initial Alaskan population that might not be readily traceable to one or another Siberian prehistoric population and culture except in a general sense. Given that there was rapid and random change, aggregations or clusters of neighboring New World groups into culturally and/or biologically distinct units would be a sign of mutually common ancestry as much as fission subsequent to arrival in their new territories. Although the amount of archaeological field work in Siberia near to and north of the Arctic Circle is much less than in districts further south, nevertheless the limited number of far northern 14 C -dated Late Pleistocene sites is one indicator of there likely having been but a very small population in western Beringia. If we assume that for every archaeological site known for a given time period and geographic district, there are 50 others that have not been discovered or destroyed, and assuming that any site represents a band of 20 people, then western Beringia had less than 1,000 people from which were drawn the initial and later founders of Alaska. This is, of course, only guess work, but estimates of population size at historic contact in Siberia and Alaska are supportive, even though environmental changes have occurred since the end of the Pleistocene.

What was the Cultural or Technological Level of the Migrants?

It is easy to identify some of the technology, social behavior, skills, and economic strategies necessary for contemporary high Arctic life by reviewing ethnographic accounts of various polar groups. For the western Eurasian Arctic, major groups living above the Arctic Circle include the Komi, Nentsey, Saams (Lapps), Entsey, Naganasans, Evenks, Dolgans, and Kets. For the eastern Eurasian Arctic there are Yakuts, Evens, Yukagirs, Chuckchi, and Koryaks (Levin & Potapov 1964; Malet 1998). For Alaska, Canada, and Greenland, there are various bands of Eskimos and Athabaskans (Damas 1984). All these groups possess similar skills, values, and equipment needed for living in a very cold and chancy environment. For each of the various, readily preservable, culture elements made of stone, bone, or earth, such as weaponry, fishing gear, various tools, pottery, and housing, the archaeological evidence for trait antiquity and evolution is often



FIGURE 7. Site localities: 1) Kets, Russia; 2) Gosiderev Log-1; 3) Kurtak, Russia; 4) Dvagslaska, Russia; 5) Ust-Kan, Russia; 6) Razboinich'ya, Russia; 7) Kaminnaya, Russia; 8) Denisova, Russia; 9) Okladnikov Cave, Russia; 10) Mal'ta, Russia; 11) Kurla I, Russia; 12) Zhoukoudian Upper Cave, China; 13) Niah, Borneo; 14) Minatogawa, Japan; 15) Boisman II, Russia; 16) Diuktai Cave, Russia; 17) Berelkh, Russia; 18) Ushki, Russia; 19) Anangula, USA; 20) Dry Creek, USA; 21) Wizard Beach, USA; 22) Spirit Cave, USA. Ice Packs: A) Okhotsk Sea Pack Ice; B) South Coast Bering Land Bridge.

abundant on both local and regional scales. Of more perishable and behavioral items such as clothing and social organization, prehistoric evidence is much less and usually indirect and more inferential. However, I feel it is generally fair to say that high Arctic Upper Paleolithic life was much the same as that in the Eurasian sub-Arctic, but with a few absolute needs for survival. Two stand out in my mind, as the title of this article suggests.

Many of the same vertebrate species found in the Late Pleistocene steppe and forest-steppe of Siberia have been found in deposits of similar age in Alaska (Kurt & Anderson 1980; Guthrie 1990; n.d. Ovodov, on-going personal communications 1998–2000). These include mammoth, horse, bison, bovids, lions, and many others, but interestingly, not the widespread and seemingly numerous Siberian hyenas (Kurt & Anderson 1980). Human terrestrial hunters and gatherers of southern Siberia would have had to make no major technological changes as far as the types of animals hunted farther north was concerned. However, intensity and duration of winter cold, mobility, patchiness of resources, and possibly other limiting factors such as large predators, had to be accommodated in order to come near to and cross the Arctic Circle. The cold would have been dealt with by the innovation of windtight fur clothing assembled with small tailoring needles, one of which Russian associates Ovodov, Martynovich, Pavlova, and I recovered in a 20,000-year-old stratum during our archaeological testing of a limestone grotto called Dvagliaska Cave in Khakatia Autonomous Republic, July, 2000. That stratum and deeper ones contained a rich representation of extinct Late Pleistocene fauna, including hyenas. Here, the environment may have been steppe or forest-steppe.

Further west, in the Altai Mountains, Ovodov's excavations in a deep limestone mountain-top cave called Razboinich'ya turned up a complete dog skull that ^{14}C -dated to about 14,000 yr B.P. This relic of an early domesticated wolf must have been carried into Razboinich'ya by hyenas that were its principal Pleistocene occupants. This cave, along with those lower down the mountain valley utilized by Mousterians, would have been surrounded by forest, as today. Along Siberia's Late Pleistocene east coast, south of probably most of the pack ice that would have covered the Sea of Okhotsk further north, the hunting of abundant marine mammals (Asiatic fur seal, walrus, sea cow, dolphin, whale, etc.) might have been both a beach and boating endeavor as at the Neolithic coastal site of Boisman II, south of Vladivostok (Popov *et al.* 1997). Hence, Siberian natural history suggests three major food and shelter resources—marine coast, forest steppe and steppe, and mountain valley forest systems, which in turn could have served as three regional homelands. I proposed this multiple Siberian and Primorian ecological homeland idea in 1979 (Turner 1983), and it has been further elaborated upon by Goebel (1999).

TEETH, NEEDLES, DOGS, AND SIBERIA

The key Late Pleistocene inventions that are needed to endure and traverse the extremely hostile Late Pleistocene winter environment above the Arctic Circle are tailored windtight fur clothing, and dogs to aid in transporting the bulky equipment needed for high Arctic survival. The minimal equipment inventory would have had to have included for each family in a migratory hunting party: tent poles, ropes, pegs, and bulky skin covers; extra clothing and wraps for infants; cooking and other household items; hunting and fishing equipment (traps, spears, hooks, lines, clubs, and so forth); various filled or empty containers including skin or string bags; heavy fur bedding; spare materials for repairs of weapons, utensils and clothing; emergency food and fuel; and critically, carefully protected glowing “slow match,” or dust-dry tinder for use with a “fire drill” to quickly start cooking and warming fires in hearths or possibly stone oil lamps at each winter hunting encampment. Being fireless at nightfall on a midwinter hunting trek would have been a serious if not lethal situation. The amount of time spent in any given encampment would have depended mainly on the availability of local food and fuel resources, either autarchic or under the control of other groups. Similarly, as groups attempted to live further and further north, the more influential must have been local resource control as well as climate and vast distance on population structure, dispersal and mating behavior. Mates were likely drawn from the small local populations, which would have contributed to the founder effect that I infer was the chief evolutionary process that produced the previously mentioned three major New World dental groups. Life in the far north was very difficult as seen even today in low population density, short life span, high levels of osteoporosis in middle-aged women, and spinal defects (Laughlin 1981).

These two key inventions for colonizing the high Arctic of eastern Eurasia, the small tailoring needle for precision sewing, and the domestication of the dog from its northeast Asian wolf ancestor, *Canis lupus*, are according to archaeological discoveries, very late developments in Pleistocene prehistory. Tailoring needles are known for several sites in Late Pleistocene Eurasia (Soffer 1985). In eastern Siberia there is evidence for wolf domestication (Ovodov 1998). No examples of Late Pleistocene dogs have been found in Europe (Soffer 1985). While watercraft such as dugouts, birchbark canoes, or hide-covered boats, known in one form or another today for most Siberian groups, may well have been known and used for summer travel along the northward flowing rivers like the Ob, Yenisei, and Lena, and along the eastward flowing Amur, there is only suggestive evidence of their Late Pleistocene use based on the choice of riverside encampments such as Afontova Gora and Kurtak on the Yenisei, Mal'ta on an ancient lake shore, and others. The physical remains of at least one dog dating back to some 14,000 yr B.P. (Ovodov 1998) is about the same age as the dog “burial” discovered by Dikov (1997) at the

Kamchatkan site of Ushki. Dogs can aid in transporting loads of equipment and supplies with the use of carrying bags (like saddle bags), the two pole travois, and sleds of various size and complexity. Dogs would also have been valuable for locating, stalking, and attacking prey animals; guarding against other large Late Pleistocene carnivores; serving as a source of companionship; and in an emergency, food.

What Languages Might the Founders Have Spoken?

The prehistoric New World populations have been in place long enough to have lost all one-to-one language relationships between those spoken in the New and Old Worlds, except possibly for Alaskan Eskimo-Aleut and Siberian Chuckchi (Ruhlen 1975). However, language family or phyla relationships have been proposed suggesting connections between all New World language families and those found in Siberia (Greenberg 1987; Ruhlen 1994), although much controversy revolves around this proposal (Greenberg 1990). Recently, Ruhlen (1998) suggested a linguistic link between Alaskan Na-Dene and Ket, whose few remaining settlements along the Yenisei River basin might also have been the homeland for Na-Dene. No linguistic connection has ever been proposed between Ainu and any New World language, despite the relatively close proximity of Ainu settlements on Hokkaido and Sakhalin with Alaska. Just as biological and cultural features might have changed rapidly in the small population context of the Siberian Arctic, surely so would have languages. This is exemplified by the few and seemingly genetically unrelated Paleosiberian languages of Northeast Siberia (Ruhlen 1975; Crystal 1987).

Conclusions

In sum, the dental evidence based on highly concordant observers cited previously shows that the dental morphology of Native Americans, past and present, is most like that of Late Pleistocene and recent Northeast Asians; much less like that of all Southeast Asians, Polynesians, and Micronesians; and very dissimilar to that of Australians, Melanesians, South Asians (India), Europeans and Africans. While the story of New World and Pacific Basin prehistory and human dispersal therein is far from complete, there is a useful outline in hand. Any scenario for the peopling of the New World that does not also consider relevant biocultural and natural history events around the world, as has been the objective of our dental anthropological surveys and affinity assessments, fails the evidentiary test of holism for acceptability. There is no better example of the value of worldwide synthesis than the *tour de force* by geneticists Cavalli-Sforza and col-

leagues (1994). These workers find in gene distributions and other biocultural considerations the same sets of large-scale Old and New World intergroup relationships that are revealed by dental morphology. They say: "The genetic patterns in the Americas fully confirm the three waves of migration suggested by dental and linguistic evidence . . ." Cavalli-Sforza *et al.* (1994:340).

Hence, taken altogether, I find the combined evidence compelling for inferring an interior Beringian route for the Clovis or epi-Clovis Paleo-Indians. Ancestral Aleut-Eskimo may have boated and trekked along the southern coast of the land bridge at about the same time as the epi-Clovis folk were exploiting the resources of, and drifting eastward across, the great Beringian plain. Language, ecology, animus, distance, or some combination may have kept these two groups from interbreeding while in transit across the land bridge. Aleut-Eskimos are viewed as having had a Primorian homeland where they developed their wet-cold maritime adaptation in the Amur-Hokkaido sea mammal district, whereas interior dry-cold Northeast Siberia was more likely the homeland for both ancestral Paleo-Indian and later Paleo-Arctic (Diuktai-Na-Dene) peoples. Thus, I continue to envision three more-or-less distinct migration waves made up of small numbers of migrants, a scenario that Powell (1993) has agreed with, using a different method for analyzing my published dental data. Their spoken tongues were ancestral to Greenberg's Macro-Indian, Aleut-Eskimo, and Na-Dene phyla. Each of these three possessed an advanced level of upper Paleolithic cultural developments, including dog domestication. Their biological and cultural diversification had already evolved before they reached Beringia and their different routes, geographic isolation, small population sizes, and arrival times caused and maintained their differentiation with the possible exception of some manner of post-Pleistocene biocultural mixing in the Gulf of Alaska region (see especially G. Scott [1994] on this problem). I find nothing in the Siberian, Primorian, or Alaskan bioarchaeological record to suggest entry much before Clovis or epi-Clovis, nor do I see evidence of Sundadonty in the New World, although divergent and convergent dental microevolution has occurred within the general Sinodont pattern. Claims for Sundadonty (Lahr 1995; Powell & Rose 1999), I suggest, are due to wear-influenced observation error. Finally, the message of the long occupation of southern Siberia and a much shorter record above the Arctic Circle probably signals that the New World was unreachable until climate-related technical advances had been made. I suggest that two critical advances were the domestication of the wolf and the innovation of the fine tailoring needle. Beginning in the early 1960s, when I first began to excavate in the Aleutian Islands with W. S. Laughlin, A. P. McCartney, J. A. Turner, G. Bair, E. & K. Harris, and others, I felt that Late Pleistocene watercraft played some role in the coastal peopling of the New World, at least as far as the Alaska Peninsula. However, near-freez-

ing Arctic water temperatures and infamous Arctic stormy seas are even more hazardous to human survival than winter blizzard whiteouts on land. However, periods of starvation on land last longer than drowning in icy seas, so the chances of crisis survival on land are better.

Finally, can a systems-oriented characterization be made of the cultural and biological complex that enabled native Siberians to reach and cross Beringia? At present, one can do little more than recite the biocultural characteristics of the far northern peoples of Europe, Siberia, Alaska, Canada and Greenland at the time of historic contact. Despite the romantic notion of the noble New World savage, I see very few signs of environmental conservation, intergroup co-operation, sexual equality, humanitarianism, or other idealistic and noble qualities. On the other hand, it seems patently evident that the human qualities needed for the conquest of the Arctic must have included high intelligence, toughness, endurance, intragroup co-operation and sharing, creativity, and well-tested ways of dealing with the natural environment. Not only were there long periods of intense cold stress, and repeated starvation episodes, there were also long periods of suffering with mentally-depressing, winter darkness. Teeth not only help inform us about who these Arctic pioneers were, and where they came from, but the considerable amount of dental chipping, breakage, and loss also exhibits how difficult life was for humans in the world's most harsh environment. Even the bone-crushing teeth of Pleistocene Siberian hyenas rarely show this kind of tooth damage and loss.

Abstract

The title of this essay symbolizes my holistic orientation and current understanding of Siberian and New World anthropology. In this paper I examine information from dental morphology, osteology, archaeology, linguistics, genetics, natural history, and oral tradition to assess eight key questions about the origin of Native Americans. These questions are: (1) Where was the regional ancestral homeland(s)?, (2) what route(s) were followed?, (3) when was the time(s) of arrival?, (4) how many migrations were there?, (5) what is the genetic affinity between Native Americans and peoples of the Old World including the Pacific Basin?, (6) how many migrants were there?, (7) what was the cultural or technological level of the migrants?, and (8) what languages might they have spoken? It is my explicit theoretical view that the best explanation for the peopling of the Americas requires integration of all lines of both diachronic and synchronic evidence, not just one or two as is the most common approach today. As I interpret these multiple lines of evidence it would appear that the most powerful single hypothesis, among several possible based on one or another line of evidence, envi-

sions: (1) *A Siberian homeland*, (2) *a Bering land bridge route*, (3) *a relatively late time of arrival*, (4) *a very few number of migrations*, (5) *a genetic affinity primarily with Northeast Siberians*, (6) *very few migrants*, (7) *a sophisticated Arctic-adapted culture*, and (8) *languages related to those of eastern Siberia*. Before humans could live near to, or above, the Arctic Circle ($66^{\circ} 33'$), and eventually reach Alaska, they had to have had a biocultural system that supplied solutions to several harsh environmental problems. In my view, the next major task for students of Native American origins is developing hypotheses about that system.

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CHAPTER SEVEN

THE MIGRATIONS AND ADAPTATIONS OF THE FIRST AMERICANS CLOVIS AND PRE-CLOVIS VIEWED FROM SOUTH AMERICA

A.C. Roosevelt, John Douglas and Linda Brown



Until recently, in most anthropology textbooks, the first Americans were identified as the Clovis people, specialized spear-hunters whose ancestors crossed the land bridge from Siberia through the ice-free corridor into the North American plains about 12,000 years ago at the end of the Ice Age (Fagan 1987; Fiedel 1987, 1992; Haynes 1964; Martin 1967; Wormington 1957).¹ Decimating the large game with their deadly, bifacial fluted projectile points, they moved south through upland grasslands until they reached the tip of South America about 11,000 years ago. In opposition to this view, some researchers (*e.g.*, Bednarik 1989; Bryan 1991; Dillehay 2000; Dixon 1999; Krieger 1964; Meltzer 1993; Willey & Phillips 1958) have long claimed that the human colonization was begun as early as 15,000 or even 20,000 years ago by opportunistic foragers who did not yet have carefully flaked projectile points. Collecting a wide range of foods with simple stone tools flaked on only one side, these people migrated south through diverse habitats long before the big-game hunters, according to the pre-Clovis theory. But whenever they were supposed to have arrived, the first people were thought to have been Asian Mongoloid people from northeast Asia (*e.g.*, Turner, this volume). A map of possible Paleoindian sites discussed in this chapter is presented in Figure 1.

Today, nearly 70 years after the first excavations at Clovis, New Mexico, new sites and new dates from both South and North America have created problems for the earlier theories about the migrations and adaptations of the first Americans, as we explain in this chapter. Consensus has not kept up with new findings, and most current scholarly analyses and media scenarios (Begley & Murr 1999; Booth 1999; Dillehay 2000; Dixon 1999; Egan 1999; Preston 1997; Wilford 1999) do not fit the accumulated data. Although the tide of public and scholarly opinion has definitely turned against Clovis as the earliest culture, nonetheless, the data we have reviewed give no definitive evidence for human cultures in the Americas before about 12,000 yr B.P. All cultures represented as older

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FIGURE 1. Map of possible Paleoindian sites throughout the Americas. Question marks indicate questionable dates. Drawing by Joyce Pendola of Conde Nast. (Roosevelt 2000a, courtesy of Natural History.)

than *ca.* 12,000 years fail to withstand careful scrutiny. Furthermore, all well-documented early cultures have at least some artifacts carefully flaked on both sides; there are no exclusively unifacial industries. Current evidence summarized in our chapter suggests that the habitat, subsistence, artifacts, and chronology of early Paleoindians are not those predicted by either the pre-Clovis or Clovis migration theories (Roosevelt 2000a, 2000d). In addition, despite claims for early migrations from Europe and elsewhere, the biology of Paleoindian populations throughout the hemisphere consistently points to a geographic origin in northeast Asia, not in Europe (Chatters *et al.* 1999), southeast Asia, or Africa (Powell 1993; Steele & Powell 1993; Turner, this volume).

The dissolution of the evidence for pre-Clovis cultures does not resurrect Clovis as ancestor, however. Clovis does not appear to have been the earliest culture in the Americas and did not set a hemispheric cultural-ecological pattern. First, the early peoples occupied a much wider range of habitats than that envisioned in the Clovis theory. Cool upland plains, the preferred Clovis habitat, was not the habitat of most Paleoindian cultures, which by now have been found in diverse regions: northern, wooded river basins, temperate and tropical zone seacoasts, tropical lowlands, and southern pampas, as well as the upland plains favored by Clovis people. Second, in contradiction to the Clovis theory, remains from many early sites indicate that most people lived by broad-spectrum foraging of diverse modern biota, not by specialized hunting of now-extinct megafauna (see Dillehay & Rosen, this volume). Most well-documented, published sites contain no megafaunal bone contemporary with the human occupations, but often do contain such foods as fruits, nuts, vegetables, fish, shellfish, and small game animals. Specialized big-game hunting was not the “bread-and-butter” of most Paleoindians but merely one regional group’s particular adaptation to cool, dry grasslands poor in the diverse foods consumed by most other groups. Third, the many new radiometric dates from sites throughout the hemisphere make Clovis just one of several, contemporary regional cultures developed soon after the initial migration, not the ancestor of the other early Paleoindian cultures. With the spate of new measurements, the age of plains Clovis culture has been revised significantly downward to an initial age of no more than 11,200 yr B.P. and an ending age of about 10,800 yr B.P., as we document below. The hemispheric Clovis horizon, based mainly on scattered, poorly-dated finds of rare, presumed fluted points,² has evaporated in the face of regional sequences that have now been established in South America. Three different regions of South America now have consistent radiocarbon series beginning just about the same time as Clovis. These southern cultures, thousands of miles away and entirely distinct from Clovis culturally and ecologically, cannot very well be derived from Clovis. Contemporary with the earliest secure Clovis dates, in South America there already were maritime foragers on the Pacific coast,

guanaco hunters in southern pampas, and tropical forest foragers in the eastern tropical lowlands. Few of the securely dated and documented early Paleoindian southern cultures have fluted, parallel-sided points; most have unfluted, triangular points of different basal forms.

The body of this chapter critically evaluates the two most popular theories about the peopling of the Americas — the Clovis and the pre-Clovis theories — in the light of current data on early North, Central, and South American Paleoindian cultures and in their stead offers an alternative — the “Clovis in Context” theory. Our discussion and illustrations document key cultures and sites throughout the hemisphere, but focus particularly on the Clovis and Monte Alegre cultures in southwestern North America and eastern South America, respectively, because their similarities and differences exemplify the significance of the new data. The new picture of Paleoindian cultures based on hemispheric data not only changes understanding of the initial human colonization and adaptive radiation in the Americas but also has interesting implications for general theories about human evolution and human nature. In our conclusions, we summarize what we see as the possible general significance of this picture in early New World culture history and beyond, and we point to possible directions for future research.

Early Paleoindians in North America

The Clovis migration theory

In the original Clovis migration theory (Fagan 1987; Fiedel 1987, 1992, 2000; Haynes 1964; Jennings 1983; Martin 1967, 1984), the first Americans were Mongoloid people who hunted large herd game with distinctive, parallel-sided, fluted spear points named after the site near Clovis, New Mexico. Their ancestors were thought to have come from the steppes of Siberia into the Americas on foot shortly before 12,000 years ago. They went into the cool, upland grasslands of the continental interior, and there they preyed on large mammals such as mammoth, long-horn bison, horse, and camel. Since American animals were unaccustomed to human hunting, the highly efficient Clovis spear-hunting methods were thought to have quickly diminished herds, forcing people to move rapidly south through the hemisphere in search of more game. Settling the North American plains by 12,000 or 11,500 years ago, according to the theory, they moved down the Andean uplands and reached the far southern pampas by about 11,000 yr B.P. (Fiedel 1987, 1992; Haynes 1964; Lynch 1983; Martin 1967; Mosiman & Martin 1975). At different periods of research on Paleoindians,³ as they have been called, ideas about the timing of migration have varied; but the basic geographical scenario held firm for a long time.

According to the theory, this lifestyle of terrestrial big-game hunting in open, temperate habitats was typical throughout the hemisphere, and only after the large game had gone extinct, and climates warmed and sea levels rose at the beginning of the early Holocene, the recent climate period about 10,000 years ago, did people move into low-land floodplains and coasts (Fiedel 1987:82–159; Lynch 1983; Martin 1984:368–369). Only then, did they turn to more laborious forms of foraging upon small game, fish, shellfish, and plant foods and in some areas eventually domesticated local plants and animals. In this post-Pleistocene cultural period (called the Archaic) new triangular, notched, and sometimes stemmed forms of projectile points are supposed to have appeared, appropriate to the new economies (*e.g.*, Anderson *et al.* 1996; Frison 1991; Sassaman 1996). The tropical rainforests, which reseachers considered disease-ridden and poor in both game and starchy foods, were not thought to have been colonized until the spread of agriculture sometime after 5,000 years ago (*e.g.*, Fiedel 1987:82–159, 1992:84–165; Lynch 1983:89).

Early Paleoindian cultures: Universal standards of validity

This picture of the migration was elegantly simple and fit some tenets of optimal foraging theory in human evolution (see Binford 1968), but it was not based on a body of established, definitive data throughout the Americas. Few sites had been excavated and published, and most were in the North American southwest, the Clovis heartland, not in the zone that Clovis people supposedly colonized. As our discussion below illustrates, early archaeological techniques of excavation and analysis were often crude compared to today's: lacking microstratigraphic excavation, controlled piece plotting, and computerized instruments to record and analyze data quantitatively. The early dating methods were experimental, unpredictable, and imprecise. Most of the sites of the supposed Clovis descendants in the colonization zone were poor in diagnostic cultural and biological remains and lacked suites of reliable, well-documented Pleistocene radiocarbon measurements. Knowledge of site formation processes was not yet well developed, and the implications of stratigraphic complexity were not as widely recognized as today, so disparate objects that had come together in layers through disturbances were often taken to be contemporary. Lacking detailed publications for most sites, conclusions of hemispheric scale lacked adequate data from the specific regions.

Since the discovery of Clovis, archaeologists' growing experience and changes in research technology have led to an improved body of published data for clarifying early New World human history and ecology. Critical evaluation of cultures has been aided by advances in taphonomy, the study of the complex processes of deposition of sediments

and objects in sites (*e.g.*, Behrensmeier & Hill 1980). New radiocarbon dating methods have allowed taxonomically-identified biota and individual artifacts from sites to be directly and precisely dated (Taylor 1987:90–95). Together, these advances have led to the development of universal criteria of reliability against which to evaluate proposed early Paleoindian occupations (Bowman 1990; Aitken 1990; Taylor 1987, 1992, 1997; Taylor & Aitken 1997; Haynes 1992; Mead & Meltzer 1984; Meltzer & Mead 1985; Taylor 1987; Roosevelt 1998a, 1998b, n.d.a, n.d.b; Roosevelt & Morrow n.d.; Stafford *et al.* 1991; Toth 1991).

According to the universal criteria, valid early Paleoindian sites have consistent series of accurate, statistically precise dates with standard-error bars no greater than about 300 years. The dates are run on single, taxonomically-identified single objects of carefully cleaned, biologically identified cultural carbon of adequate quantity derived from recorded stratigraphy in primary association with artifacts, documented in peer-reviewed published accounts. Especially reliable are dates on individual fruits of identified botanical species or the purified amino acids extracted from individual bones or teeth of prey animals (Stafford 1990; Stafford *et al.* 1991). Valid regional cultures, moreover, would be represented by several such sites with comparable dates, artifacts, and biological remains.

In contrast, a site would not be reliably dated if it has few or no dates, statistically inconsistent dates, or dates with large standard error bars greater than about 300 years. Dates would not be valid if they were run on inadequate sized, incompletely cleaned samples, biologically-unidentified carbon samples, or samples in contact with older carbon contaminants. Dates would be unreliable if run on aggregate carbon samples amassed from disparate stratigraphic contexts or on samples without documented primary cultural association. Cultures would be questionable if represented by only one site, especially if the site is a problematic one that has been in existence for decades without resolution of reliability problems according to the standards. Cultures, also, would be considered invalid if they were reported only in non-specific, non-peer reviewed publications or from unpublished, oral presentations or personal communications.

To be useful, reliability scrutiny needs to be even-handed. There has been a common tendency for archaeologists to scrutinize the reliability of pre-Clovis sites or Clovis rivals, but, as we describe next, current claims for the age of Clovis rely on dates, sites, and cultures with obvious reliability problems. When *all* such obviously invalid sites, dates, and cultures are set aside, a very different picture of the Paleoindian migration comes into focus.

Clovis: Younger than we thought

In the new picture, Clovis is no longer the earliest established Paleoindian culture it was assumed to be before much was known about the archaeology of regions outside of the Clovis sphere in North America. Over the decades, as dating methods have developed, Clovis has grown progressively younger. Initially said to be from 12,000 to 11,500 years old (Haury *et al.* 1959), its age was first trimmed to between 11,500 to 11,200, (Haynes 1964, 1966, 1987), and then to the period from 11,200 to 10,900 yr B.P. (Haynes 1992). Review of the early sources shows that, in each era, the ages scholars quoted for Clovis were considerably earlier than that indicated by the statistics of the available dates. Recently, in this vein, several scholars called for a return to a $> 11,500$ yr B.P. beginning date for Clovis (Fiedel 1999a, 1999b; Taylor *et al.* 1996), and, in fact, much of the Paleoindian literature cites the span from 11,000 to 11,500 or even to 12,000 yr B.P. as the established age of Clovis (Fiedel 1987:56; Ferring 1994; Frison & Bradley 1999; Hannus 1990; Jennings 1983:50; Preston 1997) and, by implication, the assumed age of any New World complex that has parallel-sided or fluted points (*e.g.*, Gramley 1993; McAvoy & McAvoy 1997; Di Peso 1965; Ranere & Cooke 1991).

According to the criteria of reliability, however, no Clovis site has valid dates that early; all such dates fail the criteria on multiple counts (Roosevelt 1998a). The only ones at *ca.* 12,000 years were solid-carbon dates run early in the history of radiocarbon dating and are no longer accepted by dating specialists (Aitken 1990:77; Bowman 1990:31–32; Taylor 1987:76–82). Solid-carbon dates from the same site context were unreliable and could range as old as 12,000 and as young as 7,000 yr B.P. (see Figure 2). When Clovis sites were redated with the improved technique of gas counting, none produced dates as early as 12,000 years. Although recently, dates between 11,600 and 11,300 yr B.P. have been claimed for the culture (Fiedel 1999a; Taylor *et al.* 1996), these dates do not withstand scrutiny by universal standards of radiocarbon dating. Some are rare, statistical outliers in direct conflict with large series of consistently later dates on associated samples from the same context (as at Lehner, Murray Springs, and Domebo, discussed below); others are from nonhuman carbon in soil horizons earlier than the human occupations (as at Clovis, see discussion below; Figure 3; Roosevelt 1998a, n.d.b., and Appendix 1). Many plains Paleoindian carbon dates were on carbon vulnerable to contamination by too-old carbon. Such dates often were run on samples compiled from small, botanically unidentified dark flecks in disparate stratigraphic locations in sites, some of which have now been shown experimentally to be contaminated with large amounts of geological carbon, such as lignite coal and/or carbonate (Holliday 1997:50–148, 232–233; Mill Iron site, Haynes 1992:324; Dent site, Dixon 1999, Haynes *et al.* 1998; Lewisville site, Stanford

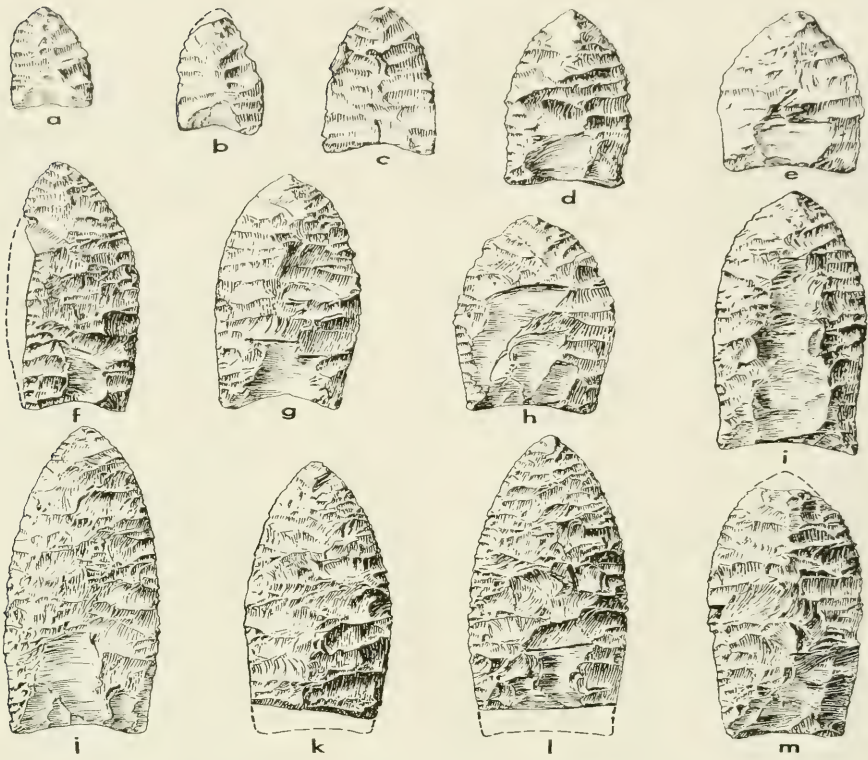
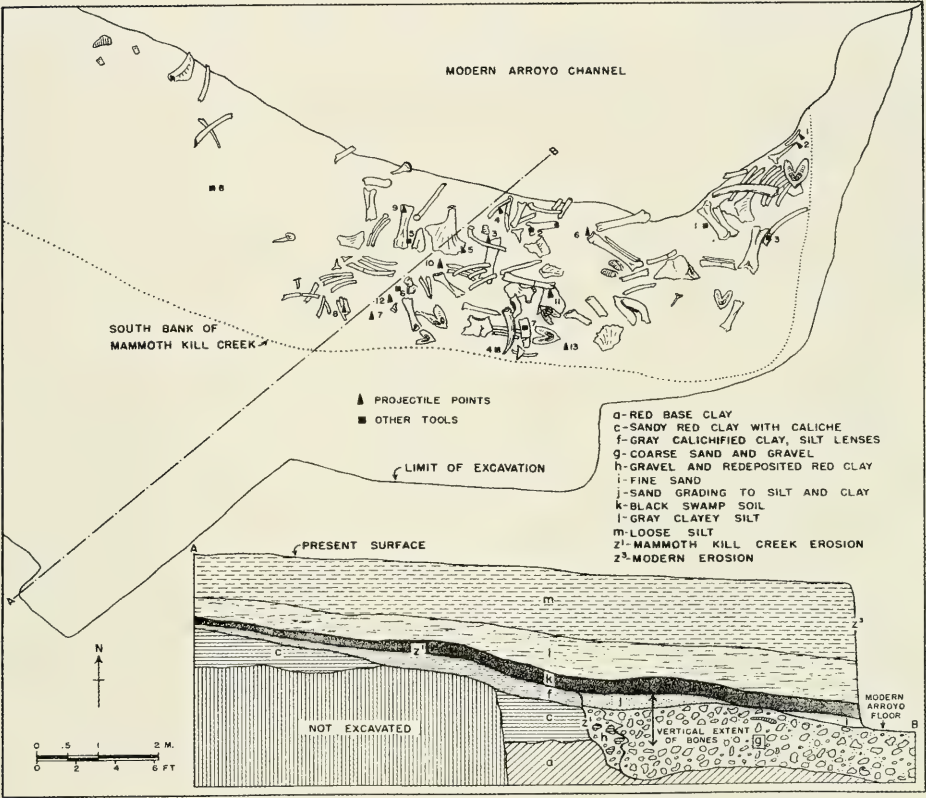


FIGURE 2A. The Lehner Clovis site, Arizona. Projectile points (Haury *et al.* 1959:17, figure 13, used with permission).

1983), materials abundant in Cretaceous strata incised by the streams by which many Clovis sites lie (Harbour 1975). Most of the others were run on tree charcoal, which by its nature has an inherent age older than the date of use by humans, since trees grow for many years before being cut for firewood (Aitken 1990: 8; Bowman 1990:15; Roosevelt 1998a). Other early Clovis samples were too small or too poorly cleaned to achieve necessary accuracy (as at Clovis, Domebo, UP Mammoth site, Colby site, see Appendix 1), and many dates have error bars from 350 to 600 yr, a range considered too large for precise, definitive dating (Bowman 1990; Taylor 1987:102–104, 123–126).

The process of chronological attrition by reliability evaluation means that there are only five high plains Clovis sites (Lehner, Murray Springs, Domebo, Dent, and Anzick) that have consistent series of precise, accurate dates on cultural carbon from documented contexts. Forty-six assays on 35 adequate-size samples of rigorously-cleaned, biolog-

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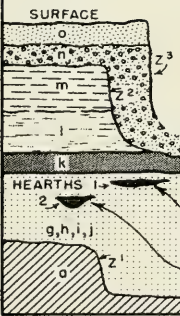
LEHNER SITE PROFILE	RADIOCARBON DATES			ANTEVS' GEOLOGICAL ESTIMATES
	U. ARIZONA	U. COPENHAGEN	U. MICHIGAN	
	6356 ± 450 (A-31) 6877 ± 450 (A-33) 7133 ± 350 (A-34) AV. 6789 ± 450 7205 ± 450 (A-32) 7022 ± 450 (A-30) 8330 ± 450 (A-40d) 10,900 ± 450 (A-40b) 12,000 ± 450 (A-40b)	11,180 ± 140 (K-554)	11,290 ± 500 (M-811)	Z³ = MODERN ARROYO STARTS CUTTING 1880'S Z² = ALTITHERMAL ARROYO 7000-5000 B. P k = PLUVIAL Z¹ = MAMMOTH KILL CREEK HUNTS 13,000 B.P. OR OLDER

FIGURE 2B. The Lehnner Clovis site, Arizona. Stratigraphy and inconsistent radiocarbon dates (Haury *et al.*, 1959:25, figure 16, used with permission).

ically identified, cultural carbon from documented stratigraphy in the five sites with documented Clovis lithics have produced no statistically-consistent dates earlier than the period *ca.* 11,200 to *ca.* 10,800 yr B.P. (see Appendix 1). Many writers now cite 11,200 yr B.P. as the age of Clovis, but this is only the earliest possible beginning age for Clovis, not the average age of Clovis sites, since the reliable Clovis date series averages no earlier than 10,900 years ago (specifically, $10,848 \pm 20$ yr B.P.). Moreover, Clovis proponents have claimed that the culture has a corrected age of 13,500 calendar years and thus is earlier than other Paleoindian cultures (Fiedel 1999), but this assertion is based on the intercalibration of *only* the *unreliable* Clovis dates (those run on unidentified carbon, carbon from contaminated contexts, or samples without documented cultural or stratigraphic association)⁴, not the *reliable* dates, which calibrate at *ca.* 12,906 yr B.P.

Remarkably, the dates from the famous Clovis type site at Blackwater Draw Locality 1 fail to meet reliability standards on all counts. Only three Pleistocene dates for that culture there have been reported from the site: $11,630 \pm 400$, $11,170 \pm 350$, and $11,040 \pm 500$ yr B.P. (see Appendix 1) (Boldurian & Cotter 1999; Haynes & Agogino 1966; Haynes *et al.* 1966; Hester *et al.* 1972; Damon *et al.* 1964:100–101). Said to be carbonized plants in secondary literature and thus widely assumed to be cultural charcoal, the primary reports show that they were wet-preserved aquatic plants, a noncultural carbon source subject to metabolic contamination by geological carbonate, which is present at the site (Bowman 1990:26; Cotter 1938, 1939; Damon *et al.* 1964; Hester *et al.* 1972; Holliday

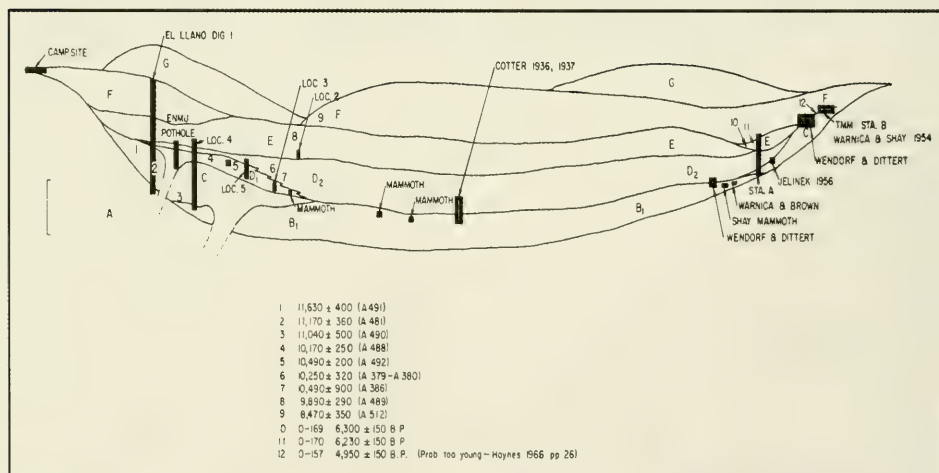


FIGURE 3. Stratigraphy and radiocarbon dates on natural carbon at Clovis, Blackwater Draw, New Mexico. (Hester *et al.* 1972:174, figure 130, used with permission).

1997:232–233; Roosevelt 1998a; Stafford *et al.* 1987). In addition, these samples were too small to be adequately cleaned and thus could not be counted long enough to achieve acceptable error bars. Furthermore, the site report shows that two of them (1 and 3) came from noncultural associations stratigraphically several feet below the bone bed (Figure 3). The only one (sample 2) that had cultural association was in strata that were deformed by a spring that had moved materials vertically in the site (Haynes & Agogino 1966:816, figure 5B; Hester *et al.* 1972, figure 130; Warnica 1966). As a result, the eponymous Clovis site still remains undated after more than three decades of research (Roosevelt 1998a). Its age could readily be resolved by AMS dating of individual amino acids extracted from one of the mammoths (Stafford 1990; Stafford *et al.* 1991) in primary association with artifacts (Hester *et al.* 1972:71–87).

The *ca.* 11,500 age of another site, Domebo, Oklahoma (Leonhardy 1966), claimed to support an earlier age for Clovis (Fiedel 1999a; Taylor *et al.* 1996), also is invalid under the criteria for reliability. This age was based on a single, imprecise outlier date with a much too-large error of 450 years. The valid site age is securely established at *ca.* 10,900 yr B.P. by seven consistent dates run on four samples of distinct materials (two mammoth bones and two wood fragments) found associated with projectile points in the bone bed (Appendix 1).

Aubrey in Texas (Ferring 1989, 1990, 1994, 1995; Humphrey & Ferring 1994), also widely claimed as proof for an initial Clovis age of 11,600 yr B.P. (Fiedel 1999a; Stanford 1991; Taylor *et al.* 1996), also is not a valid Clovis site. The only two supposed Clovis dates, $11,590 \pm 90$ and $11,540 \pm 110$ yr B.P., meet few of the criteria of reliability. They were run on aggregates of stratigraphically-dispersed, biologically-unidentified carbon subject to contamination from the peat, old wood, and calcium carbonate recorded at the site (Ferring 1994:31–118). Most unfortunate, the samples were not collected from an intact, sealed terminal Pleistocene stratum but from a disconformity, an erosion surface on a 15,000 to 20,000-year-old geological alluvial stratum composed of materials eroded from coal-bearing Cretaceous bedrock of the region (Ferring 1989, 1994: 25, figures 3.8 and 3.9). Such a context would not be a secure find-place for dates, according to the criteria. Moreover, the dates were not on individual specimens of culturally utilized botanical remains or fauna, and neither date has specific stratigraphic unit proveniences in Clovis-age, terminal Pleistocene strata, documented with detailed stratigraphic sections of specific excavation units. In addition, these dates do not have published measured stable carbon isotope ratios, without which the exact age range of radiocarbon dates is unclear (Taylor 1987:123). Also troubling, no specifically Clovis-style lithics have been documented in stratigraphy at the site, and no stone artifacts have been illustrated or tabulated in print or related individually to specific excavation layers, features, or dates. This

site could, however, still be dated reliably by assays on the taxonomically-identified cultural charcoal, animal bone, or burned lithic artifacts present in the site, once the excavation details are published.

There is, then, no empirical support at all for an age of 12,000 to 11,500 yr B.P. for the Clovis culture. By standard dating criteria, the age of the Clovis culture is well-established from the large series of dates from the five documented Clovis sites in the time range from *ca.* 11,200 to 10,800 yr B.P., with an average age of *ca.* 10,900 yr B.P. These dates, which are on a wide range of different cultural materials — human bone, prey-animal bone, and charcoal — are consistent regardless of material. This revision of the chronological position of Clovis means that many other, distinct New World cultures are its full contemporaries, not its descendants. It also means that one North American culture previously considered a Clovis contemporary must be its predecessor, as we shall describe further on.

Where did the Paleoindians come from and how did they come?

The current archaeological and biological evidence does not support the assumptions of the Clovis migration theory about Paleoindian migration routes. For example, there are no instances of Late Pleistocene, pre-Clovis fluted points at the entry-point to the Americas; all are early Holocene (Clark 1991; Yesner 1996, n.d.). Despite intensive efforts, research also has produced no Clovis-like, big-game-hunting cultures in the interior of northeast Asia. Interior Siberian cultures of the relevant periods have unfluted, lanceolate or triangular, stemmed bifaces and subsistence by mixed foraging (Figure 4a) (Derev'anko 1998; Dikov 1996; Powers 1996). Late Pleistocene cultures along the north Asian coasts have broad-spectrum foraging cultures with stemmed, unfluted bifaces (Aikens & Higuchi 1982; Aikens & Akazawa 1996), some of which (Figure 4b) were shaped by techniques characteristic of Clovis and other Paleoindian bifaces. The refined Clovis bifacial stone flaking techniques (including long, regular, diagonal, parallel soft-hammer thinning) and certain tool forms (large curved blades), sometimes claimed as evidence for Paleoindian origins in European Late Pleistocene Solutrean culture (Stanford 1991, and this volume) were also common in Late Pleistocene east Asia (Aikens & Higuchi 1982; Aikens & Akazawa 1996; Derev'anko 1998; Powers 1996). However, tool forms particular to Clovis — such as the parallel-sided fluted point — are unique local forms with no demonstrated links to Old World complexes in Europe or Asia (Haynes 1964), so they do not constitute evidence for Paleoindian geographic origins in the Old World.

Interpretations of the skeletal biology of Paleoindians in terms of geographic origins also have changed over the decades. Metric and nonmetric cranial characters have been

CLOVIS AND PRE-CLOVIS VIEWED FROM SOUTH AMERICA

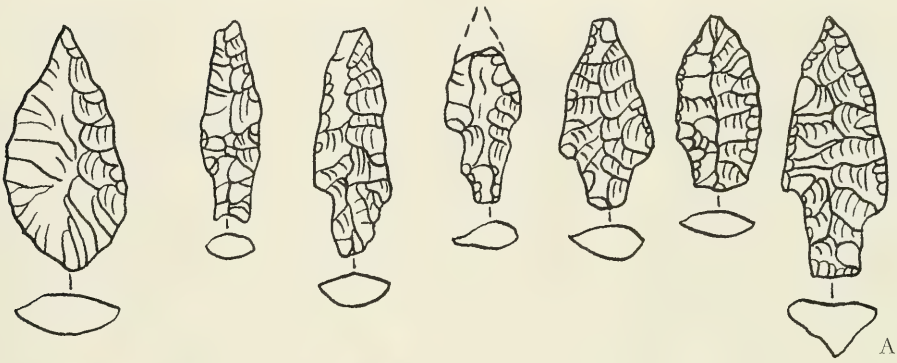


FIGURE 4. Late Pleistocene stemmed projectile points from east Asia. A. Lithic assemblage of the Ushki Lake culture, Siberia (Derev'anko 1998:327, figure 202, used with permission). B. Triangular stemmed projectile points, Kusakayana, Higashi, Osaka Town Museum, Japan. Courtesy of the municipality of Osaka.

reviewed for approximately 25 directly-dated skeletons of terminal Pleistocene and early Holocene age (Lahr 1995; Powell 1993; Powell & Neves 1998; Powell & Rose 1999; Scott & Turner 1987; Turner, this volume). This review revealed that Paleoindians differ in cranial morphology from both modern North American Amerindians and modern Mongoloid peoples such as Japanese and Han Chinese. However, despite much media interest in the suggestions by some archaeologists that Paleoindians might therefore be culturally and biologically descended from caucasoid Europeans (Begley & Murr 1999; Booth 1999; Egan 1999; Preston 1997; Wilford 1999), the cranial traits at issue are not considered to be under strong genetic control (Turner, this volume) and were vanishingly common in Europe in the terminal Pleistocene (*ibid.*). In contrast, multiple characters of human teeth known to be under genetic control are very common in both Paleoindians and Northeast Asian populations. Paleoindian incisor shape, molar cusp patterns, and root numbers have a high percentage similarity with the east Asian pattern termed Sinodonty, but a low percentage similarity with Late Pleistocene and Holocene Europeans' teeth (Turner, this volume). Mitochondrial DNA "X-factors" claimed to link Paleoindians to White Europeans also occur widely in Asia (Merriwether, this volume). There is, therefore, no statistically significant empirical data that relates Paleoindians more closely to Europe genetically than to Asia, but there are several bodies of data that link them closely to east Asia. Some anthropologists have suggested (Neves & Pucciarelli 1991; Neves *et al.* 1996) that Paleoindians must have come across the sea from the Pacific Islands because their crania are more like those of Pacific Islanders than they are like present northeastern Asian populations or Amerindians. However, in the Late Pleistocene the cranial traits at issue were common throughout east Asia (Turner, this volume). Although some researchers have implied that cranial morphology means that a certain Brazilian skeleton must be from an African or southeast Asian population (Neves *et al.* 1996), the skeleton in question has not been directly dated nor compared to any others by dental morphology, the more appropriate feature for genetic relatedness issues.

There is some new evidence about the possible routes that early migrants took within the New World. The Clovis migration theory had depicted humans as entering and moving through the hemisphere on dry land because they were supposed to have lacked watercraft. Several researchers have argued against these assumptions, pointing out the advantages of coastal resources and the lack of archaeological evidence along the supposed Clovis migration route (Bryan 1978a; Fladmark 1978; Gruhn 1994). Over the years, evidence has accumulated suggesting that at least some of the first people migrated coastwise (Erlandson, this volume). Some researchers now suggest that the interior ice-free corridor was not open at the appropriate times to have been a route for the first migrants (Roberts & Julig n.d.), and others suggest that the northwest coast was almost

entirely unglaciated, allowing easy passage of migrants with watercraft (Dixon 1999:19–43; Dixon *et al.* 1997). Another body of evidence for coastal adaptations by Paleoindians is the stable carbon isotope data from two early Holocene human skeletons from the U.S. northwest, which manifest patterns of stable carbon isotopes, suggesting some reliance on marine food resources (Chatters 1998; Dixon *et al.* 1997; Johnson *et al.* in press; Powell & Rose 1999). In addition, in Daisy Cave on San Miguel Island off the southern California coast, an ancient garbage midden with abundant coastal food remains of fish, shellfish, and marine birds has produced terminal Pleistocene radiocarbon dates between *ca.* 10,500 to 9,500 yr B.P. (Erlandsen & Moss 1996; Erlandsen *et al.* 1996; Erlandson, this volume). These sites are not direct proof for an initial coastal route, for none are early Paleoindian in age, but they are our only evidence for the time being, since the then coast probably is now under ~ 60 meters of water after post-Pleistocene sea level rises, and it has been difficult to locate coastal sites of the right period (R. Gruhn, personal communication). However, such finds do show that some northern Paleoindians did include marine adaptations, which the Clovis migration theory did not allow for. More conclusively, as we shall see below, faunal evidence from South American sites places coastal and lowland riverine rainforest adaptations securely in the earliest regional Paleoindian cultures.

When did they come, before or after the invention of projectile points?

The pre-projectile point horizon theory is a long-standing alternative to the theory of the Clovis migration and has appeared in many different forms (Bednarik 1989; Bryan 1978b, 1986, 1991; Dillehay 2000; Dixon 1999; Krieger 1964; Willey & Phillips 1958). It assumes that people came into the Americas before anatomically modern humans and upper Paleolithic cultures had appeared in Europe; they therefore would have lacked the capacity and technology to make fine and bifacial projectile points for specialized hunting of big game. Instead, they were supposed to have made crude stone flakes, and edge-trimmed cobble tools, and tools of perishable materials.

After many years of research, however, neither the predicted chronology nor history of technology has been borne out. No valid American cultures pre-date *ca.* 12,000 years ago and none has exclusively unifacial tools. All verified early Paleoindian cultures possessed some kind of bifacially flaked tool, and most made bifaces, although these are rare among the formal artifacts of many industries. One important element of the pre-projectile point theory, however, has been borne out by recent research: that the earliest people would be generalized foragers, not specialized big-game hunters.

The Calico site in California, long claimed to be 100,000–45,000 years old (Leakey *et al.* 1968; Simpson 1978), never produced early stone specimens that archaeologists could

agree were human-produced. Furthermore, it lacks other secure hallmarks of human activity: human skeletal remains, utilized subsistence remains, and spent fuels. These absences suggest that this is a purely natural deposit pre-dating human occupation (Haynes 1973a). The Old Crow site in the Yukon region of Canada also was long thought to be evidence of the pre-projectile point horizon on the basis of a single radiocarbon date of 26,000 to 29,000 yr B.P. on bone speculated to have been used by humans when fresh (Bonnichsen 1978; Harington *et al.* 1975). However, follow-up dating showed that the undoubted cultural materials at the site were not even Pleistocene in age (Taylor 1997:88, table 3.5). Similarly, several human skeletons from the tar pits on the southern California coast were claimed to be pre-Clovis, pre-projectile point people, but check-dating showed they were of much more recent date, instead (Erlandson & Moss 1996; Taylor 1997: 88, Table 3.5; Taylor *et al.* 1985). At Pendejo Cave, New Mexico, burned animal bones and charcoal supposed to represent human activity (MacNeish 1991, 1992; MacNeish *et al.* 1993) are not securely associated with undoubted tools and unambiguous evidence of the human presence (Lynch 1990).

So far, then, all these North American pre-Clovis candidates fail the universal criteria test outlined above: statistical consistency, biological identification, secure cultural association, and replicability among sites. Some researchers continue to espouse such sites, without addressing the specific evidence problems. But there still is absolutely no good evidence in North America for an entry of humans before *ca.* 12,000. All human remains are anatomically modern, and all valid early Paleoindian cultures have the full range of basic lithic manufacturing technology of Upper Paleolithic cultures.

Whatever the ecological or social conditions that encouraged people to venture from Asia — whether the rapid warming of the terminal Pleistocene, or pressure from the rise of sedentary, pottery-making cultures in northeast Asia, or some other factors — the results of many decades of research still constrain their entry to at, or around, 12,000 years ago, no earlier.

Projectile point cultures in North America before Clovis?

Numerous projectile-point cultures have been claimed to pre-date Clovis, but all fail to meet the criteria of reliability.

Some of these cultures have statistical evidence of old-carbon contamination. The site on a knoll at Mesa, Alaska, is claimed by its excavators (Kunz & Reanier 1994; Reanier & Kunz 1995) to be a pre-Clovis, early Paleoindian ancestor nearly 12,000 years old, but this interpretation belies its radiocarbon date statistics and lithics, both of which indicate late, not early Paleoindian, age. The only two pre-Clovis Mesa dates are from

samples that gave pairs of statistically inconsistent dates indicating a problem with old carbon (Figure 5). The large series of twelve precise, late Paleoindian dates accord with the late Paleoindian style of the associated projectile points (Goebel 1999; Roosevelt n.d.b). A now-discredited single pre-Clovis date from Putu, Alaska (Alexander 1987), was on carbon from prehuman subsoil, not on cultural carbon associated with artifacts (Reanier 1996). Similarly, the bone dates from Bluefish caves, northern Alaska (Morlan & Cinq Mars 1982) remain questionable because of old-carbon contamination from calcareous rocks, lack of cultural association, and lack of published specifics on the dates (Ackerman 1996:511–512).

At other supposedly early projectile point sites, lignite coal, a source of too-old carbon, has been identified. One example, Mill Iron, a bison bone bed with adjacent campsite, has repeatedly been claimed as a *ca.* 11,600-year-old culture either contemporary with, or ancestral to, Clovis (Fiedel 2000:55–56; Frison 1996, 1999; Stanford 1991). The site is contaminated with Cretaceous coal that lies a few inches below the cultural stratum (Frison 1996: 8–9, figures 1.12, 1.13; Frison *et al.* 1996). Stratigraphically and culturally, this is a single occupation bison-kill site, not an occupation sequence, and yet its radiocarbon dates range widely over a span of 11,000 years (Frison 1996:8, table 1.1; Haynes 1992: 324). Radiocarbon dates from the same site contexts are statistically inconsistent with each other. Characteristically, they were run on aggregates of dispersed, botanically-unidentified carbon. Check-dating of one of the samples revealed it to be contaminated with large amounts of lignite coal measured at > 24,000 years old (Frison 1996:11; Haynes 1992:324, 1998). Although the excavator states, “There does not appear to be any reason to suspect contamination of the charcoal samples used for the radiocarbon dates” (Frison 1996:8), the demonstrated coal contamination of both an underlying stratum and of a radiocarbon sample from the bone bed obviously give such a reason for suspicion. Mill Iron’s actual age, like Mesa’s, is probably *ca.* 10,000 yr B.P., judging from the late Paleoindian technology and typology of the points (Bradley & Frison 1996: 66–67). Its age could readily be resolved by AMS dating of individual, botanically-identified specimens of burnt plants and the purified amino acids of several individual bison bones or teeth.

The *ca.* 16,000-year-old Meadowcroft rockshelter site (Adovasio *et al.* 1983), also rich in coal fragments on the surface and in buried strata, also was dated by aggregates of stratigraphically-dispersed, taxonomically-unidentified carbon. That contamination has occurred is indicated by the fact that the carbon solutes were more abundant than, and dated older than, the carbon solids (Haynes 1991). Its lithics were rare, and its paleoenvironmental materials inconsistent with its radiocarbon age. Meadowcroft dating problems could be resolved by AMS dating of several individual pieces of botanically-identi-

ROOSEVELT, DOUGLAS AND BROWN

FIGURE 5. Inconsistent radiocarbon dates from Mesa, Alaska (Kunz & Reanier 1994, used with permission).

Locality	Date	SE	Material	Sample ID	
B	11,660	80	hearth charcoal; tools associated	Beta-55286	Split sample this one was run w/57430; does not overlap at 2 standard deviations
B	11,190	70	hearth charcoal; tools associated	Beta-57430	Split sample this one was run w/55286; does not overlap at 2 standard deviations
Saddle	10,980	280	hearth charcoal; tools associated	Beta-50429	Split sample this one was run conventionally, 50430; does not overlap at 2 standard deviations
B	10,240	80	hearth charcoal; tools associated	Beta-55283	
A	10,090	85	hearth charcoal; tools associated	Beta-50428	
Saddle	10,070	60	hearth charcoal; flakes associated	Beta-69898	Not in Science
B	10,060	70	hearth charcoal; tools associated	Beta-52606	
B	10,050	90	hearth charcoal; flakes associated	Beta-69900	Not in Science
B	10,000	80	hearth charcoal; tools associated	Beta-55285	
Saddle	9,990	80	hearth charcoal; flakes associated	Beta-55282	
Saddle	9,945	75	hearth charcoal; tools associated	Beta-50430	Split sample this one was run AMS, 50429; does not overlap at 2 standard deviations
B	9,930	80	hearth charcoal; tools associated	Beta-55284	
B	9,900	80	hearth charcoal; tools associated	Beta-69899	Not in Science
B	9,900	70	hearth charcoal; flakes associated	Beta-57429	
Saddle	9,730	80	soil charcoal; flakes associated	Beta-36805	

fied charcoal for each level and by assessment of the potential old-carbon effect by dates directly on the coal from the surface of the site and from its vicinity.

Other claimed pre-Clovis sites with bifaces in the southeastern U.S., such as Cactus Hill (McAvoy & McAvoy 1997), also lack consistent series of Clovis and pre-Clovis dates on taxonomically-identified cultural carbon securely associated with well illustrated and quantified artifacts from documented stratigraphic contexts.⁵ The “pre-Clovis” and “Clovis” ages from Cactus Hill were a tiny minority of the dates from their levels, in which the majority were early Holocene dates. The “Clovis” points were actually not fluted Clovis points, but vaguely shaped parallel-sided points that could easily be late Paleoindian or Archaic, and the “pre-Clovis” lithic samples were too small for valid statistical separation from the “Clovis” lithics and insignificantly distant stratigraphically (McAvoy & McAvoy 1997:169–170, table 6.3). By the dating standards, such cultures are not currently credible contenders for Paleoindian ancestors.

A New Paleoindian Ancestor: Nenana, Alaska

A new candidate for Paleoindian ancestor in the New World is found in the Nenana culture of the Nenana and Tenana River basins in Alaska. Given the redating of Clovis, Nenana is now the oldest well-documented American culture with secure radiocarbon ages (Goebel *et al.* 1991; Hoffecker *et al.* 1993, 1996; Yesner 1996, n.d.; West 1996:293–374). The culture fulfills all the criteria of reliability. It has consistent series of dates run on several different biologically-identified materials. The materials had been rigorously cleaned and have small error bars. There is secure association of the dates with undoubted cultural materials; all but one site are free of old-carbon traces; and the patterning of dates and cultural materials is replicated at several sites.

The Nenana culture is known from seven archaeological sites of which four have produced a consistent series of 22 radiocarbon dates ranging from about 11,800 to 10,700 yr B.P. (see Figure 6 for the series from Broken Mammoth). The dates are on individual specimens of several different materials including taxonomically-identified biota: charcoal, willow charcoal, large mammal bone, Wapiti bone, swan bone, as well as associated soil carbon. Only one site, Dry Creek, produced evidence of old carbon, in this case, lignite (Goebel *et al.* 1991, figure 3, left; Hoffecker *et al.* 1996). Unlike the Clovis people, Nenana people were not specialized big-game hunters. Subsistence adaptations documented at several sites include broad-spectrum collecting of diverse resources: mostly medium-to-small game, such as Dall sheep, Wapiti, and especially wetland birds, fish, molluscs, and plants from a diverse habitat mosaic of forest, floodplain, and plains. Specimens of now-extinct megafaunal prey are very rare, and the only mammoth iden-

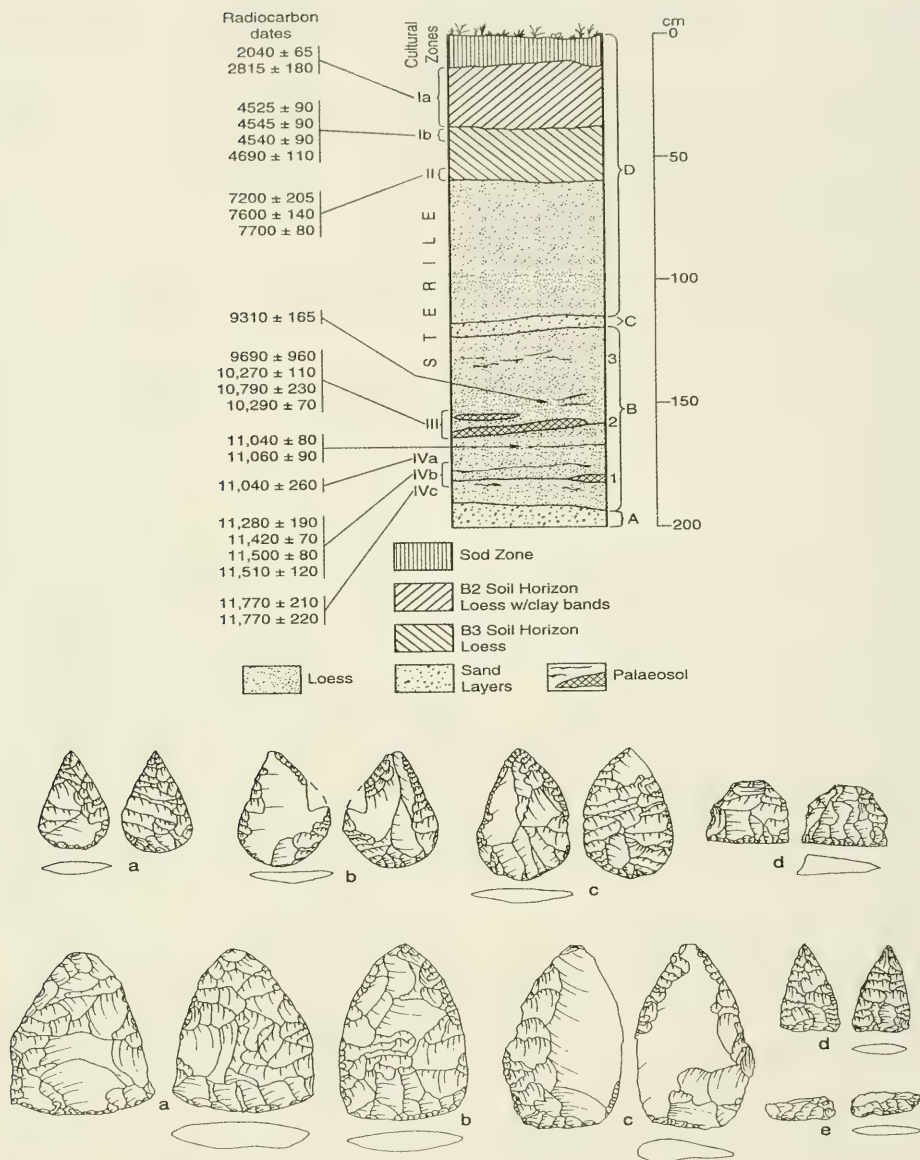


FIGURE 6. Nenana culture, Alaska. Top: Stratigraphy and radiocarbon dates at Broken Mammoth site (West 1996:314–315, figure 6–4, table 6–4, used with permission). Bottom: Early Nenana artifacts from Dry Creek and Walker Road, Alaska (West 1996:349, 361, figures 7–8, 7–14, used with permission).

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tified gave significantly earlier dates than the other biota, indicating use of fossil ivory. Nenana bifacial lithics include common small, triangular bifaces, probably used as knives, but not parallel-sided, fluted bifaces on the Clovis model. Its other tools tend to overlap substantially in form and manufacture the other early Paleoindian complexes in North America (Goebel *et al.* 1991).

As a broad-spectrum foraging culture of mixed habitat, Nenana presaged the characteristics of the newly discovered Clovis contemporaries in South America.

Paleoindians in Latin America

Clovis and Pre-Clovis theories fail south of the border

Neither Clovis-like, big-game hunting, fluted-point cultures nor pre-Clovis forager cultures have been demonstrated indisputably in Mesoamerica or South America. As we shall see, the points originally identified as Clovis either turn out to be Holocene in age or, when analysed in terms of lithic manufacture, turn out to lack the fluting and the straight-sided shape characteristic of Clovis. And, surprisingly, there are still no indubitable Latin American cases of megafauna slain by terminal Pleistocene hunters. Similarly, neither pre-projectile point or pre-Clovis projectile point cultures have been verified in South or Central America. As in North America, the relevant sites and cultures either are not Pleistocene in age or do not have the claimed cultural characteristics. All Pleistocene cultures whose nature has been adequately established and published fail to predate *ca.* 11,200 years, and all have some bifacial artifacts, not exclusively unifacial artifacts.

Instead, diverse broad-spectrum hunting and collecting, regional Paleoindian cultures contemporary with Clovis, have been found in diverse environmental contexts, often with lithic complexes characterized by triangular, sometimes stemmed bifaces. Such triangular bifaces and broad-spectrum adaptations had initially been assumed by Clovis theorists to be post-Pleistocene, an analogy with the transition in parts of North America from Paleoindian fluted-point big-game hunters to Archaic triangular-point foraging cultures, described above. However, also as mentioned above, triangular and/or stemmed bifaces and broad-spectrum foraging cultures are common Late Pleistocene forms in much of the Old World and therefore are forms that would have been known to the earliest migrants, rather than merely local post-glacial American innovations, as originally assumed by Clovis theorists. Furthermore, triangular points are now established by radiometric dating to be of terminal Pleistocene age both in North and South America; thus they pre-date the Archaic forms and cannot be their descendants. In addition, the trian-

gular forms found in terminal Pleistocene Paleoindian sites in Latin America are morphologically different from the triangular points of Archaic, post-Pleistocene Indians in North America. The North American Archaic points at issue are typically side-notched for attachment (Anderson *et al.* 1996:10, figure 1.2; Frison 1991:79–109), while the early South American points (illustrated in figure 10) never show this form. In this important hafting feature, there is no formal or temporal overlap between the two areas and therefore no reasonable expectation of a historical relationship.

Incomplete knowledge of the cultural and ecological characteristics of Paleoindians and their possible ancestors in the early days of research thus has tended to obscure the character and historical significance of South and Central American cultures in the peopling of the Americas.

Central America and Northwestern South America

In Middle America, most sites once thought to represent Clovis occupations were either just surface finds of vaguely Paleoindian or early Archaic projectile points or excavated sites with indeterminate artifacts with few or widely ranging dates that made it impossible to determine the nature of cultural remains, their age, and their relationship with biota. The artifacts supposed to be Paleoindian either lacked identified biological remains and consistent, precise radiocarbon dates on cultural carbon, or lack published lithic tool representations that establish their forms as fluted, parallel-sided “Clovis” points, as some assert (Ranere & Cooke 1991; Gruhn & Bryan 1977). There are no Pleistocene sites with fluted points, contemporary megafauna, or human skeletons. Some examples of the problems at the claimed early sites are telling. Northern Mexican sites classified as Clovis simply amount to finds of indeterminate, unassociated bifaces (*e.g.*, Di Peso 1965). In Central Mexico, Tepexpan “Man,” a human skeleton once thought Paleoindian, produced an age of less than 2000 years when dated directly (Taylor 1992, table 25.5). At Los Tapiales, Guatemala, a few indeterminate bifaces without identified food remains were associated with three disparate Late Pleistocene and Holocene dates on botanically-unidentified carbonaceous materials; although the points were described as fluted, illustrations show no evidence of fluting (Gruhn & Bryan 1977).

In the Isthmian area of lower Central America and Northwestern South America, a Clovis occupation has long been hypothesized, but neither Pleistocene fluted points nor megafaunal kill sites have been documented or dated (Ranere & Cooke 1991; Ardila 1991; Ardila & Politis 1989). The “Clovis” points from lower Central America (Dillehay 2000; Lynch 1983; Morrow & Morrow 1999; Ranere & Cooke 1991; Snarskis 1979), are not parallel-sided, fluted points and are not dated to the Pleistocene. Some are wide,

short, concave-sided cutting tools with waists or stems and often ears or deep, basal concavities and are either undated finds or finds spatially associated with pottery and Holocene dates; others are indeterminate parallel-sided points without Clovis-style flaking or fluting (Snarskis 1979, 1984; Ranere & Cooke 1991: 49). The flake scars supposed to be “flutes” are merely remnants of broad thinning flakes later invaded by pressure-trimming. The parallel sided points could align with virtually any Paleoindian or Early Archaic points in North America; the waisted shapes have no relation to Clovis forms and could only align, if at all, with North American forms that are late Paleoindian or Holocene (*e.g.*, Frison 1991:62–101, figures 2.28, 2.33, 2.37; Anderson *et al.* 1996:10, figure 1.2). Only the strong faith in the reality of a hemispheric Clovis horizon and the tools’ lack of contextual and chronological data made them seem like evidence for the migration when first reported. The few Central American lithic sites with Pleistocene dates so far have undiagnostic lithics; triangular stemmed points have turned up in areas with palynological evidence of Paleoindian occupation but have not been dated (Ranere & Cooke 1991; Pearson *in press*).

Across the Isthmus in Colombia and Ecuador, after decades of research there is still no faunal or chronological evidence for Pleistocene fluted-point, big-game hunting in upland open environments. Colombian projectile points once claimed to be Clovis fluted points actually now appear to be the laterally- or basally-thinned stems of large, triangular points (Ardila 1991; Ardila & Politis 1989:10, 13). Ecuadorian lithic industries once claimed to be Clovis fluted points also lack parallel-sided fluted points and even the earliest of their 23 associated radiocarbon dates are early Holocene (Bell 2000; Mayer-Oakes 1986:133–156), not Late Pleistocene. These industries, termed El Inga, are therefore not even Paleoindian. An upland Ecuadorian skull earlier claimed to be pre-Clovis on the basis of > 20,000-year-old thermoluminescence (TL) dates on limestone concretions and amino acid racemization of collagen, produced ages of only 2000 yr B.P. by radiocarbon dates on collagen (Davies 1978), considered the most reliable of the three methods (Taylor 1997).

Upland Colombian sites at the Sabana de Bogota El Abra rockshelters (Correal Urrego *et al.* 1972; Hurt *et al.* 1976) were once widely assumed to represent pre-Clovis, pre-projectile-point foragers, but some archaeologists now consider the evidence equivocal (Ardila 1991:276–278; Ardila & Politis 1989:18–22; Roosevelt *et al.* 1996:383). The unifacial industry was an inadequate artifact sample without plot locations, and the chronology was based on nothing more than two statistically discordant dates on biologically-unidentified materials not recorded in secure primary association with the lithics (Hurt *et al.* 1976:2, 5, 8, 12, and figure 4). The El Abra biota was a mixture of many modern and few extinct species (*ibid.*). Although another Bogota area site, Tibito, has been

identified as a pre-projectile-point megafaunal site, it too, has an inadequate lithic sample and is dated by a single date on the fauna; and Bogota sites with larger artifact samples turned out to have bifacial and unifacial flaking together (Ardila 1991:275–278; Correal Urrego 1981; Correal Urrego & van der Hammen 1977; Nieuwenhuis 1998), making the existence of a pre-projectile point complex questionable on grounds of sample statistics.

Points from northern Venezuela termed Clovis fluted points (Oliver & Alexander 1990: figure 20 and following), are, like the Isthmian points, undated bifaces distinct from Clovis points in shape and manufacture. Some claim a Paleoindian to Archaic cultural sequence from bipointed El Jobo points to Las Casitas stemmed triangular points in Venezuela (Barse 1990; Rouse & Cruxent 1963; Dillehay 2000), but neither of those point types have been recovered from stratified, dated contexts there, and none were associated with subsistence or environmental remains. This “sequence” is a guess without any empirical confirmation.

The Venezuelan site of Taima Taima is represented as a Late Pleistocene megafaunal kill site of the El Jobo culture (Bryan *et al.* 1978a; Dixon 1999:98–99; Ochsenius & Gruhn 1979). However, the site does not meet the criteria of reliability on several counts (Ardila 1991:274–275; Haynes 1974: 378; Lynch 1974:356; Roosevelt *et al.* 1996:383). It is an artesian spring deposit in contact with geological carbon sources: Miocene limestone, lignite (Ochsenius & Gruhn 1979:54), and possibly petroleum.⁶ Although many secondary sources say that this site component has consistent dates, the stratigraphically associated radiocarbon dates are highly inconsistent, ranging from *ca.* 11,000 to > 41,000 yr B.P. ago (Bryan & Gruhn 1979:53–58). Given the discontinuous stratigraphy and inconsistent dates, the association of mastodon bone with so few stone artifacts, only one or two biface mid-sections and a flake, is very insecure. Some bones were undoubtedly cut and marked by use for anvils (Rouse & Cruxent 1963, plate 4) but whether as fresh or fossil bone is an open question. Often said to have associated El Jobo bipoints (*e.g.*, Bryan 1978a; Ochsenius & Gruhn 1979:10; Dillehay 2000:128–133; Dixon 1999:98–99), none has been published from the site. The point midsection(s) from the sites lacks both ends (Ardila 1991:275) and so obviously cannot be identified as an El Jobo bipoint. The bipoints that are often illustrated in discussions of Taima Taima (*e.g.*, Dillehay 2000:111, figure 5.1) are not from Taima Taima but are undated surface finds from elsewhere (Rouse & Cruxent 1963:27–37).

The only documented, reliably-dated, early preceramic sites in these regions of northern South America give evidence for a very different sort of terminal Pleistocene occupation from the hypothesized “Clovis” or pre-Clovis horizons. They show the existence of a lowland Paleoindian occupation by mixed foragers using bifacial points that

sometimes are triangular and stemmed. Four stratified sites in tropical forest have produced seven terminal Pleistocene charcoal dates between *ca.* 10,500 and 10,000 yr B.P. (Gnecco 1994; Gnecco & Mora 1997; Lopes de Castano 1995; Lopes de Castano & Nieuwenhuis n.d.). All have abundant debitage from biface manufacture and two have triangular, stemmed formal bifaces. The food remains identified and dated at two of the sites were abundant carbonized plants representing tropical forest foraging on tree and palm fruits (Gnecco & Mora 1997).

Thus, there is still no empirical support from this region for the Clovis culture or for pre-projectile point, pre-Clovis, generalized foragers, and the Colombian and Ecuadorian highlands still lack securely dated sites with well-defined Paleoindian cultural occupations. It seems likely that there were Paleoindian occupations there, but their nature has not yet been established. The only northern sites that have a clear association of consistent dates, abundant artifacts, and identified environmental remains document the presence of biface- and uniface-using, broad-spectrum, tropical forest foragers in the terminal Pleistocene. Such an occupation does not fit the assumptions of the Clovis theory about the history of Paleoindian tool industries and ecological adaptations.

The Central Andes

In the Peruvian Andes, on the supposed highland plains route of the Clovis big-gamehunters, no finds of fluted points, no megafauna kill sites, and no pre-projectile point forager sites have been verified.

Pre-Clovis radiocarbon dates on extinct fauna and wood in caves in Ayacucho were once claimed to be evidence of pre-Clovis occupations (MacNeish *et al.* 1970, 1980, 1981a, 1981b, 1983). However, the only possible artifacts from the sites are amorphous flakes of cave rock that other archaeologists do not accept as human-made (Dixon 1999: 99–101; Lynch 1990; Roosevelt *et al.* 1996:383). A supposed pre-Clovis site at Amotepe on the north coast of Peru (Richardson 1978) was an artifact scatter lying on the surface in an area of petroleum seepage. Its crude lithics could be any age, having no sealed stratigraphic association with the only two radiocarbon dates, which are non-overlapping dates on marine-shell, a material considered unreliable for dating (Keefer *et al.* 1998; Taylor 1987:49–52).

Rather than having Clovis-like or pre-Clovis cultures in terminal Pleistocene times, Peru appears to have been populated by broad-spectrum foragers with a tradition of triangular, sometimes stemmed, bifaces. Six highland sites have stratified cultural deposits with undoubted artifacts and diverse food remains whose dates fall between *ca.* 11,000 and 7,100 yr B.P. (Lynch 1980; Lynch *et al.* 1985; MacNeish *et al.* 1981a, 1981b; Rick 1980). The earliest Paleoindian points in these sites are triangular, subtriangular, and

sometimes vaguely stemmed (Figure 7a). They are not fluted, parallel-sided points like those of Clovis, and none are associated with extinct megafauna. At the sites in this region, narrow bipointed tools are found at the Pleistocene/Holocene transition, not in the early Paleoindian cultures. The food remains vary from broad-spectrum hunting and gathering to specialized hunting of guanaco, a small camelid.

Contrary to the assumption that ocean resources would only be exploited in the modern climate era, excavations on the coast show the existence of widespread exploitation of the resources of the sea or coastal land in early Paleoindian times. Two new sites in southern Peru reveal an occupation by broad-spectrum, marine-coastal foragers at the same time as Clovis (Sandweiss *et al.* 1998; Keefer *et al.* 1998). Among their artifacts are bifacially flaked, triangular tools of quartz (Figure 7b), perhaps knives. Although some late Paleoindian tools were made of obsidian from adjacent highlands, all the foods found in the sites were from the sea coast. They included numerous anchovies, other fishes, shellfish, and coastal birds, but no extinct megafauna. The > 30 dates on cultural charcoal, shell, and faunal bone from the two stratified Paleoindian coastal sites range from 11,200 to *ca.* 9,000 yr B.P. ago (see Figure 8 for the early Paleoindian series). Elsewhere, later Paleoindian sites of the Paján culture of the Peruvian north coast have

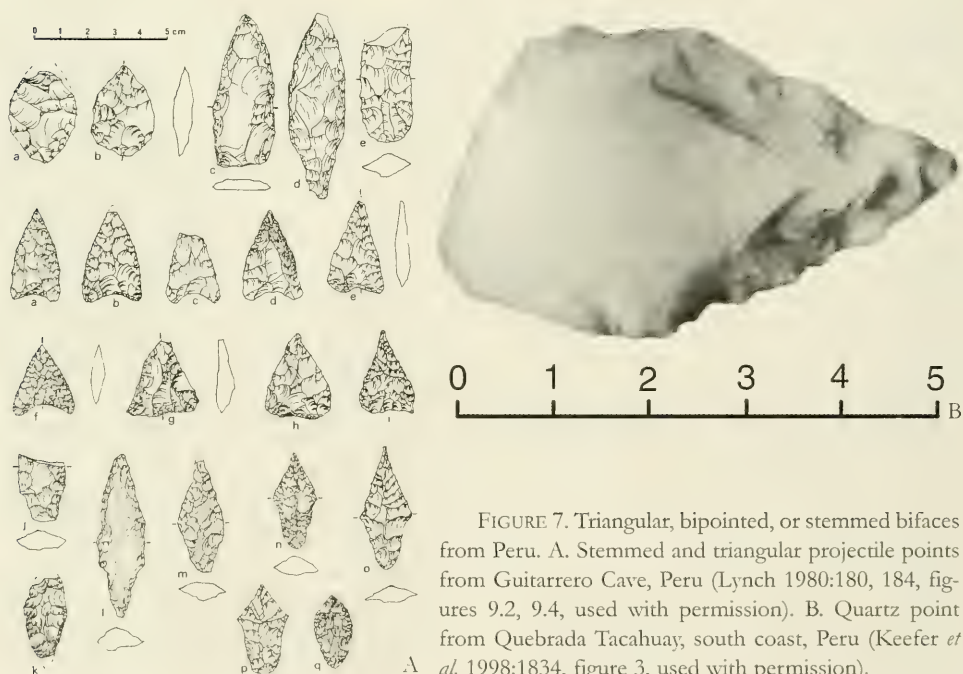


FIGURE 7. Triangular, bipointed, or stemmed bifaces from Peru. A. Stemmed and triangular projectile points from Guitarrero Cave, Peru (Lynch 1980:180, 184, figures 9.2, 9.4, used with permission). B. Quartz point from Quebrada Tacahuay, south coast, Peru (Keefer *et al.* 1998:1834, figure 3, used with permission).

CLOVIS AND PRE-CLOVIS VIEWED FROM SOUTH AMERICA

Stratum	^{14}C yr B.P.	Cal. yr B.P.	Lab no.	Component
<i>Sector I</i>				
I-2-D, level 3b	$10,274 \pm 125$	12,265–11,663	1943	TP
1970, layer 4	$10,200 \pm 140$	12,175–11,124	[(5), p. 45]	TP
I-2-B, level 4c	$11,088 \pm 220$	13,183–12,749	2024	TP
I-2-D, level 4c	$11,105 \pm 260$	13,240–12,728	1942	TP
<i>Sector II</i>				
II-1-D, level 1b M	$10,190 \pm 220$	12,271–11,008	1957	TP
II-1-C, element II-5bii	$9,850 \pm 170$	11,199–10,890	1956	TP
II-1-D, element II-5bi	$10,475 \pm 125$	12,502–12,144	1936	TP
II-1-D, level 2c	$10,700 \pm 300$	12,885–12,234	1940	TP
II-1-D, level 2c2	$10,600 \pm 135$	12,638–12,312	1939	TP
II-1-D, level 2c3	$10,560 \pm 125$	12,590–12,271	1938	TP
II-1-D, level 2c4	$10,725 \pm 175$	12,794–12,419	1937	TP
1992, level 3	$10,770 \pm 130$	12,797–12,515	1702	TP
<i>Sector IV—Unit IV-1-C</i>				
IV-1-C, level 2c	$10,507 \pm 125$	12,536–12,195	2025	TP

FIGURE 8. Radiocarbon dates from Quebrada Jaguay, south coast, Peru (Sandweiss *et al.* 1998:1830, table 1, used with permission).

consistent radiocarbon dates between *ca.* 10,500 and 8,500 yr B.P. on human skeletons, charcoal, and food remains from broad-spectrum foraging in coastal forests and rivers (Chauchat 1988, 1992). Paján individuals have generalized Asian dentitions and cranial morphologies similar to those of other Paleoindians. The Paján lithic complex is characterized by ubiquitous stemmed, triangular points (Figure 9, but no fluted points at all). As in Nenana sites, the few megafaunal bones in Paján sites are evidence of use of fossil bone, not of big-game hunting. They date several thousand years earlier than the associated Paján cultural remains.

In their cultural-ecological characteristics, the earliest known Paleoindian sites in the Central Andes tend to resemble the northwestern North American early Paleoindian culture, rather than Clovis culture. No verifiable trace of pre-Clovis or pre-projectile point cultures have been found yet.

The Southern Cone

In the Southern Cone, the earliest well-established Paleoindian cultures are contemporary with Clovis but, as elsewhere, they lack evidence of specialized big-game hunting and fluted point lithic industries similar to Clovis. As elsewhere, no secure evidence for pre-Clovis or pre-projectile point cultures has yet been found.

The site of Monte Verde near the Pacific coast of south central Chile has been characterized as a thirteen-thousand-year old, pre-Clovis site with a possible > 33,000-year-old occupation, below (Dillehay 1989, 1997). At first the site was described as a pre-projectile-point, broad-spectrum forager culture, but at some point a few narrow, bipointed projectile points were found. Although accepted by many archaeologists as valid on the basis of a small meeting of experts held there, the main questions about the site still are unanswered. The site has been questioned for several reasons (Fiedel 1999b; Lynch 1990; Roosevelt *et al.* 1996:383). It was a shallow, near-surface deposit along a boggy stream, with complex and discontinuous stratigraphy difficult to interpret in the absence of specific scale unit-level section drawings with plotted date samples and artifacts. Streamside bogs tend to be catch-alls of materials of different ages, and other bogs in the region contained natural deposits of the mired megafauna, logs, and other plants remains, according to the researchers (Dillehay 1997:127–134, 174–182, 699). The nature of the association of the only four undoubted artifacts, megafauna, and archaeo-botanical specimens with the radiocarbon dates is unclear, and no debitage from the manufacture of points was recovered, the reverse of the usual situation in which debitage greatly outnumbered points. In addition, bipointed bifaces from elsewhere in the southern cone have yielded Holocene dates reaching as late as 5,000 years (*e.g.*, Nunez 1992), not Pleistocene dates.

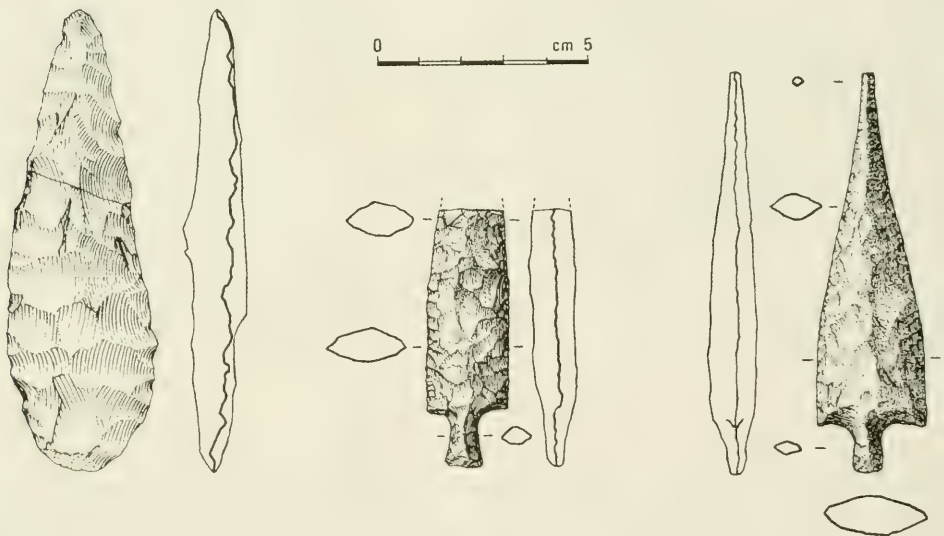


FIGURE 9. Stemmed projectile points of the Paijan culture, north coast, Peru. (Chauchat 1988:55, figure 2.6, used with permission).

There are also problems with the dating itself. Two *ca.* 33,000-year-old dates, although treated by the excavators as cultural dates, are characterized in the dating laboratories' notation form as infinite dates, which come from carbon too old to retain any carbon-14. Possible sources of old-carbon contamination in the site included bitumin on tools, a material available in nearby marine petroleum deposits, and detergent and gasoline in polluted water descending the stream from logger settlements upstream. A further chronological problem is that the pollen evidence for habitat at the time of occupation is in conflict with the insect evidence for the state of the habitat (Dillehay 1989:94–96), suggesting that materials of different ages have been combined in the site. The nature of the occupation could be clarified with further research to date taxonomically-identified, archaeobotanical specimens, the handle of a reported hafted tool, and the different materials that gave conflicting environmental evidence. Also helpful would be a further survey to try to locate and date other comparable sites and create a local sequence against which to evaluate Monte Verde.

Recent review of its data by a team of North American archaeologists resulted in a peer-reviewed statement of moral support for Monte Verde as a 12,500-year-old pre-Clovis site (Meltzer *et al.* 1997). However, that consensus has recently fallen apart, as the second volume of the published site report has circulated, and members of the meeting and others have spoken against the validity of the pre-Clovis occupation (Dincauze, personal communication; Fiedel 1999b; Haynes 1999).

Another megafaunal site in Central Chile is at Tagua Tagua, claimed to be a 11,800-year-old, pre-Clovis site (Montane 1968). However, its few dates are stratigraphically inconsistent, have large error bars, and equivocal cultural association. Nearby is Quereo, also a megafaunal site, but it has no secure evidence for human occupation contemporary with the fauna (Nunez *et al.* 1994).

In the Southern Cone in Patagonia and the southern Pampas well-established early Paleoindian occupations named after Fell Cave are characterized by lithic industries with stemmed points, not parallel-sided, fluted Clovis points (Bird *et al.* 1988; Ardila & Politis 1989; Politis 1991; Flegenheimer 1980, 1987). Although some North American archaeologists have called the southern points fluted and have cited them as possible descendants of Clovis fluted points (Morrow & Morrow 1999), those who have made comprehensive study of both the stone tools and debitage note that the points were not reduced from bifacial preforms, as were most Clovis points; that they are convex in the proximal lower third, rather than concave; and that they lack Clovis fluting (Bird *et al.* 1988; Borrero & McEwan 1997:40, figure 23; Flegenheimer 1987; Miotto 1999; Politis 1991). The subsistence remains associated with fishtail points indicate not big-game hunting but mixed hunting focused on smaller game, such as guanaco and local flight-

less birds. The rare extinct mammal bones associated with the cultural charcoal and artifacts in Fell sites have given discordant dates considerably earlier than the cultural dates; their condition, with marks of predators, suggests a mixture of natural and cultural materials (Ardila & Politis 1989; Borrero 1996; Borrero & McEwan 1997:34–44; Nami 1987), an indication that megafauna were probably used as fossil bone, not as prey. The ten cultural dates from seven early fishtail-point sites in the Southern Cone run between 11,000–10,300 yr B.P. (Bird *et al.* 1988; Politis 1991), which is comparable to the time span of the Clovis-Folsom Paleoindian sequence in North America. In the vicinity of Los Toldos on the Patagonian plateau, archaeologists have uncovered a poorly-known preceramic culture characterized by rare triangular projectile points as well as fishtail points, and a rich rock-painting tradition (Cardich 1978; Schobinger 1999). Existence of an earlier culture with unifacial, edge-trimmed tools has been hypothesized but this culture has yet to be systematically verified and dated; a single date of $12,600 \pm 600$ yr B.P. (Borrero & McEwan 1997; Cardich 1978: 296; Cardich *et al.* 1973) lacks secure cultural association.

It is remarkable that the valid Paleoindian cultures established in western South America give no evidence for the hypothetical passage of big-game hunters descended from Clovis. What they do show is the existence of a diverse group of regional cultures of broad-spectrum foragers whose lithic industries include triangular and/or stemmed projectile points. In these characteristics, these cultures are more parallel to the Late Pleistocene northeastern Asian coastal, river, and lake cultures and the pre-Clovis Nenana culture of Alaska than they are to the Clovis high plains culture with which they are contemporary. Both chronology and culture make it less likely that the western South American cultures are historically related to their contemporary Clovis, which has a different lithic tradition and subsistence orientation, than to the broad-spectrum hunting and gathering Nenana culture, which predates them.

Eastern South America

In tropical and subtropical eastern South America, as in the Andean zone, fluted-point, big-game-hunting cultures have not been verified. As in the other areas of the hemisphere, eastern South America has provided no valid examples of pre-Clovis, pre-projectile-point cultures, either. Instead, excavations by several independent researchers have established the existence of an early Paleoindian occupation by rock-painting, broad-spectrum foragers who made triangular and often stemmed projectile-points, as well as other tools.

Southeastern Brazil and Uruguay

Numerous pre-Clovis sites have been claimed for eastern Brazil, but none meet the standards for reliability. Uranium-Thorium dates $> 100,000$ yr B.P. at Toca da Esperanca were run on megafaunal bones found with crudely flaked rocks in Central, but the radiocarbon dates on charcoal with the bones were exclusively middle Holocene (Beltrao 1993; de Lumley *et al.* 1987). The Middle Pleistocene dates, thus, relate to geological substrata containing reworked faunal bones, not to the human materials, which appear to be late Prehistoric quarry debris. At another site, Alice Boer, there were pre-Clovis dates from subsoil, but the TL dates from burned stone artifacts were late Paleoindian (Beltrao *et al.* 1986). At the painted rockshelter site of Pedra Furada (Split Rock) in Piaui, the flaked stones, red-stained rock clusters, and charcoal radiocarbon-dated as early as 30,000 yr B.P. (Guidon & Delibrias 1986), appear to be products of natural processes (Lynch 1990; Meltzer *et al.* 1994; Roosevelt *et al.* 1996:374, 383). A fragment of painted cave wall found with the charcoal could have fallen from the wall deep into the soft, indistinct sand strata. All the usual signs of prehistoric human habitation, such as fragments of burned bones and carbonized food plants, were absent from the early strata.

Such claims of exaggerated antiquity have tended to obscure the existence of as many as 12 southeastern and northeastern Brazilian Paleoindian sites with more than 30 valid terminal Pleistocene dates between *ca.* 11,500 and 8,500 yr B.P. (Gruhn 1991). The sites are characterized by the presence of a wide range of bifacial and unifacial stone tool types, abundant debitage, pigment, and numerous undoubted food remains from broad-spectrum foraging. The radiocarbon dates from Perna shelter, near Pedra Furada, include a date of 10,500 yr B.P. from a hearth in undisturbed strata covering rock art panels (Pessis 1999). Sites in Goias (Schmitz 1987), in the Lagoa Santa region of Minas Gerais (Prous 1980–81, 1986a, 1986b, 1991, 1995, 1999), in Mato Grosso just south of the Amazon (Miller 1987; Vialou & Vialou 1994), and far southern Brazil (Miller 1987), have produced human skeletons or carbonized plant directly dated between about 11,000 and 8,500 yr B.P. At several sites, human skeletons are associated with burned fragments of diverse foods, pigment, and a wide range of lithic artifacts, including triangular, stemmed points. The species identified among the foods include modern tropical forest fruits, deer, varied small game, fish, and molluscs. These biological remains show that Late Pleistocene habitats were considerably moister than the current savanna woodlands and dry forests, whose vegetation has been depleted by centuries of timbering, ranching, and plantation agriculture since the European conquest. The few remains of megafauna at some sites are pieces reworked from limestone geological substrata. No use of megafauna as human prey has been verified.

There are approximately five East Brazilian skeletons with direct terminal Pleistocene radiocarbon dates or sealed, well-dated stratigraphic contexts. They have small, high faces, narrow noses, long, narrow heads, and Sundadont dentition. As mentioned above, the particular female cranium from Lapa Vermelha site, claimed by Neves to be a Negroid individual 11,500 yr B.P. old, has not been directly dated and not compared dentally with other human remains worldwide. It remains, then, a specimen of unclear significance. So far, then, all documented early east Brazilian human skeletons are generally similar morphologically to early skeletal collections from other parts of the Americas (Neves & Pucciarelli 1991; Neves *et al.* 1996).

The Lower Amazon

Triangular points with stemmed or concave bases had also turned up on the surface at sites in the Lower Amazon in Brazil and in the Guianas (Figure 10). The Amazonian points had been guess-dated to between 10,000 to 7,000 years, on the assumption that they had to be Archaic, based on their shape (Boomert 1980; Evans & Meggers 1961; Simoes 1976). However, no triangular, finely-flaked projectile points had been dated to the Holocene in the Lower Amazon, and no known Holocene cultures in the area had such projectile points or debitage (Roosevelt 1999, 2000b; Roosevelt *et al.* 1991; Roosevelt *et al.* 1996, 1997). In addition, dates from sites in central and southeastern Brazil placed such points as early as the terminal Pleistocene, as mentioned in the previous section.

Some researchers had also assumed that lowland South America would have been a savanna with small forest refuges under Late Glacial climates, and they interpreted current savanna patches along the Lower Amazon and Guianas coasts as relicts of glacial savannas once connected to the cerrado of central and southern Brazil and the llanos of Venezuela (Lynch 1983; Sales Barbosa 1992; van der Hammen & Absy 1994). Their assumptions, however, were not based on empirical data from dated terminal Pleistocene contexts and did not acknowledge the strong association of the "savanna" patches with intense recent deforestation in the locations. In fact, all pollen profiles from intact, stratified sediments radiometrically dated to Late Pleistocene age in the Amazon have spectra and stable isotope ratios typical of closed-canopy tropical rainforests, not of savannas (Absy 1979; van der Hammen & Absy 1994; Athens & Ward 1999; Colinvaux *et al.* 1994; Haberle & Maslin 1999; Roosevelt 2000c). These prehistoric spectra have small-to-moderate amounts of grass pollen, abundant tropical forest pollen, and stable carbon isotopes from -20 to -37 per mil. They showed neither the typical savanna pollen spectra, which have greater than 99% grass pollen, nor savanna carbon isotope ratios, which

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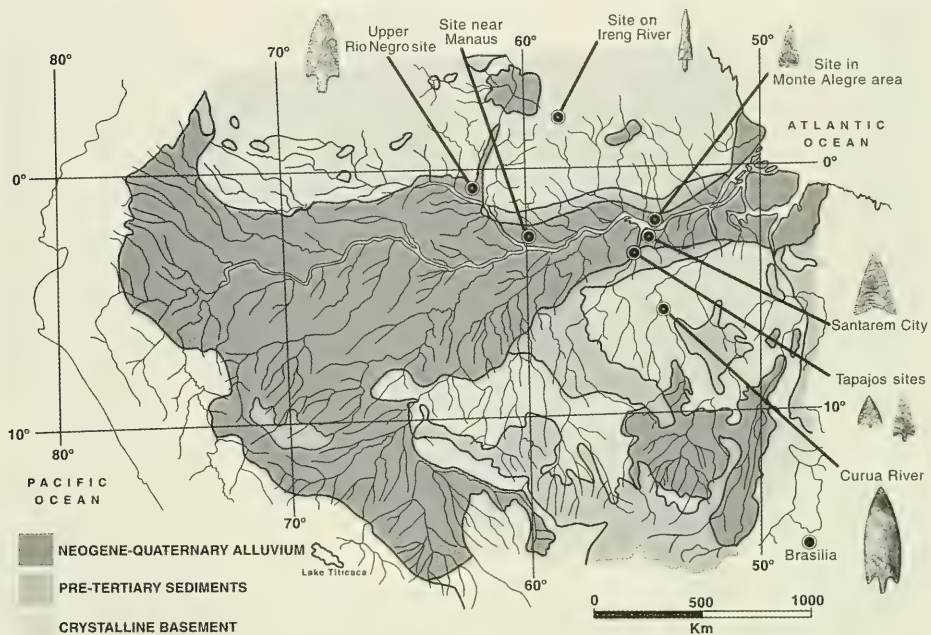


FIGURE 10. Geological map of Amazon and Middle-Lower Amazon projectile point find surface sites (redrawn and adapted from Sioli 1984:53, used with permission). Projectile points from left: Upper Rio Negro, 15cm; Ireng River (Evans & Meggers 1961: plate 8, d, used with permission); Monte Alegre, *ca.* 8cm, (collection of Victor Fuchs, photograph by A.C. Roosevelt), Tapajos River, 4.7cm, Tapajos River, 6cm, (Museu Paraense Emilio, Goeldi 1986:115, 117, used with permission and Roosevelt *et al.* 1996:373, figure 1), Santarem, 12cm (Roosevelt 1989:44, figure 8a), and Curua River, *ca.* 20cm (collection of Waldemar Caitano, photograph courtesy of Mauro Barreto).

range from -9 to -15 per mil (Bonnefille 1995; Tieszen 1991; van der Merwe & Medina 1991). Thus, the Amazonian areas where the triangular points were found probably already had tropical rainforest habitats in the Late Pleistocene.

Monte Alegre

Among the surface-find-places of triangular, stemmed projectile points in the Lower Amazon was the Monte Alegre, Para at the mouth of the Tapajos River opposite Santarem (Figure 11), about halfway between Belem and Manaus. Known for the rock



FIGURE 11. Views of Monte Alegre, Para, Brazil general vegetation, a sacure palm, a stream, and a lake. Upper left photo courtesy of Nigel Smith, University of Florida.

art in its sandstone hills (Pereira 1992), Monte Alegre has numerous large paintings of geometric images, animals, and stick-figure humans fingerpainted in red, yellow, and brown (Figure 12). The presence of colored handprints of people of all ages, including infants, in the rock art panels in the region indicated that family groups were involved. In some painted panels, abundant drops of liquid pigment had splashed below the paintings. Although published in the nineteenth century by Alfred Russell Wallace (1889) and others, the painted caves and shelters had not been excavated for evidence of human occupation.

Caverna da Pedra Pintada

To search for stratified deposits, the research team surveyed and GPS-mapped 21 caves, rock art sites, rock shelters, and open sites. Auger tests at the sites pinpointed Caverna da Pedra Pintada (Cavern of the Painted Rock) as the most suitable habitation site (Figure 13), near springs in forest overlooking lakes in the Amazon floodplain. Its walls and ceiling are covered with images generally similar to others in the region. Twelve auger cores placed inside and outside the cave sampled the stratigraphy, then 11 contiguous meter excavation units were placed on the north side of the cave. The contiguous units were placed in intact midden deposits directly below rock paintings to find well-preserved biota and check the stratigraphic levels of any spilled paint. Excavation procedures were designed to address the epistemological problems that had arisen in the interpretation of other Paleoindian sites: hand-excavation by strata and features, recording of finds in stratigraphic context by photographs, plans, and section drawings, and extensive dating of associated biota, sediment, and artifacts.

The excavations encountered *ca.* 2 m of prehistoric strata lying upon sterile yellow sand and bedrock (Figure 14). The Pleistocene preceramic deposit was a *ca.* 30-cm- thick black sand midden near the base of the stratigraphy. This black sand was overlain by tan sterile sand, above which were several dark gray, Holocene, ceramic-age deposits dating between *ca.* 7,500 and 1450 yr B.P. In the preceramic deposit were two main strata, 16 and 17, each subdivided into layers. Excavating the sediment in 1 meter squares with fine tools, we uncovered shallow hearths and lenses and abundant artifacts, food remains, and pigment. All the soil excavated was fine-screened or floated with 1.5 mm mesh and filters.

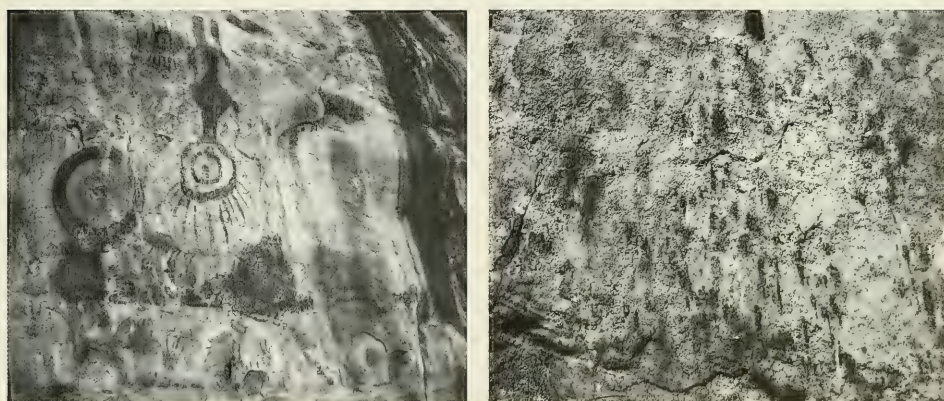
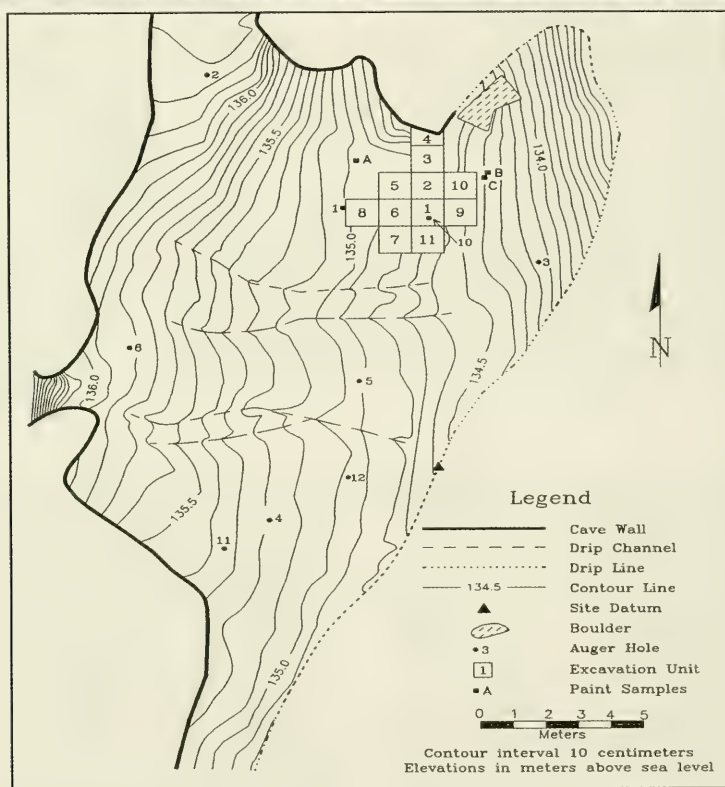
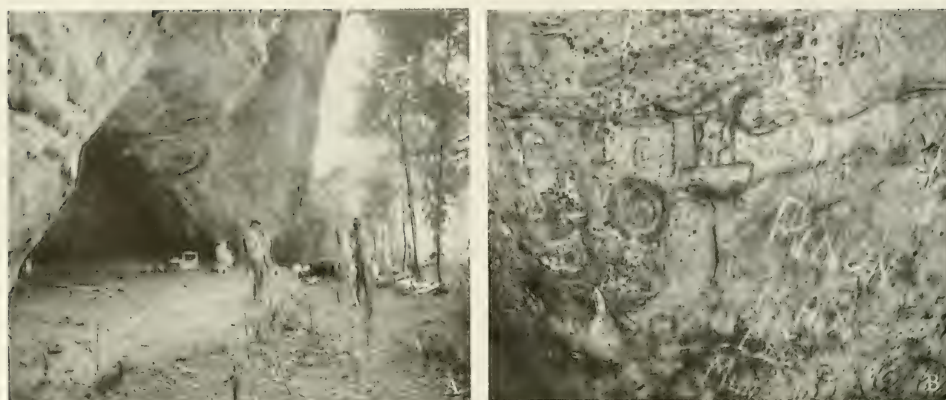


FIGURE 12. Rock paintings and spilled paint, Serra da Lua, Monte Alegre, Para, Brazil.



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FIGURE 13. Caverna da Pedra Pintada. A. View of cave. B. Paintings on north wall of cave. C. Map of excavations, auger tests, and paint samples.

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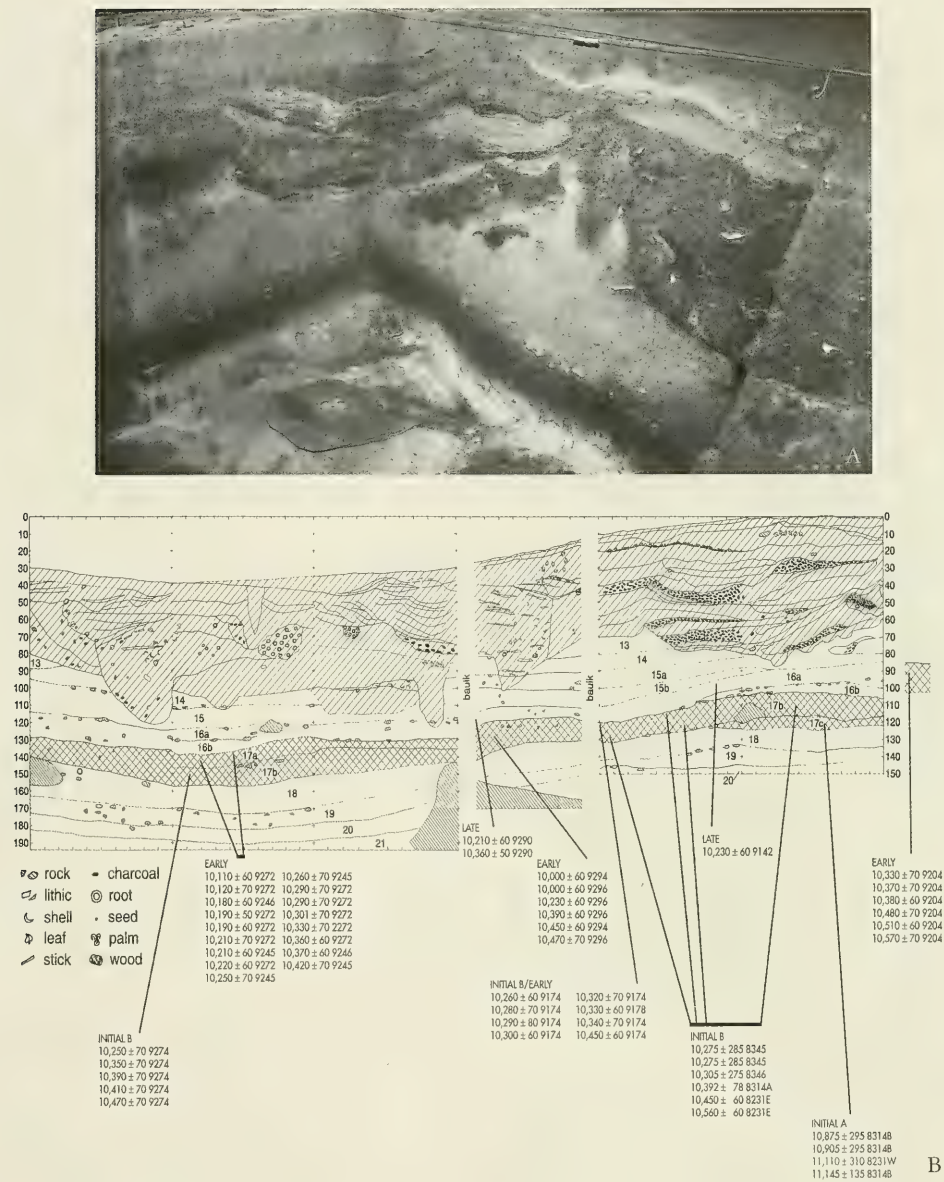


FIGURE 14. Caverna da Pedra Pintada stratigraphy. A. During excavation. B. Drawing with radio-carbon dates. (Original drawing, Roosevelt *et al.* 1996:375, figure 5.)

More than 30,000 lithic artifacts were recovered from the Paleoindian layers (Roosevelt *et al.* 1996, table 1, figure 6). In contrast, the ceramic-age layers held only a few hundred. The percentages of lithic raw materials, all from sources outside the cave, changed significantly through the five stratigraphically-distinct, phases of occupation (Roosevelt *et al.* 1996:376–377, table 1). Chalcedony predominated in the upper preceramic deposit, reaching 90% and higher in the highest stratum, 16A, but quartz crystal predominated in the lower part, reaching over 70% in the earliest stratum, 17C. The 24 formal flaked lithic tools included fragments of triangular projectile points, sometimes stemmed, slug-shaped unifacial scrapers; a graver; blade-like flakes; and others (Figure 15). The bifaces, and flakes from making them, were found from the earliest to the latest Paleoindian levels. There were abundant pigment chunks and paint drops on the stone artifacts, primarily in the earlier preceramic levels, except for one pigment chunk found at the surface. The excavated pigment, composed of iron oxides from laterite (Figure 16), had chemical composition and iron-titanium ratios comparable to the paint on the cave walls, above. Thus, at least some of the cave paintings were probably made during the early preceramic occupation.

The preceramic cultural deposit was rich in wood charcoal, burned fruit and legume pits and seeds, and fragments of burnt bone and shell, types of remains that were completely absent from the sterile subsoil below the archaeological deposit. Fifty-six radiocarbon dates were run on the carbonized plant remains by gas counting method or mass-spectrometry at three different laboratories. To increase accuracy, the date samples were run on localized, plotted, and individual botanicals identified as wood charcoal or carbonized pits of taxonomically identified trees, not on aggregate, unidentified carbon samples combined from dispersed stratigraphic contexts. Fruits have short life-spans compared to trees, so dates on fruit pits permit narrower time-spans to be measured. To test for possible carbon contamination and old wood, dates were run on both the solids and solutes of many carbonized plants, and the results were statistically identical, regardless of material, consistent with a lack of contamination. To check the contemporaneity of the cultural remains found with the biological remains, 10 burned lithic artifacts were dated by thermoluminescence (TL) dates, and three sediment samples were dated by optically stimulated luminescence (OSL) (Michab *et al.* 1998). To “blind” the dating experiment, the TL lab team was not informed of the radiocarbon OSL results in advance of dating the stone tools.

The preceramic radiocarbon date series runs between *ca.* 11,200 and 10,000 yr B.P. (Figure 17) (Roosevelt *et al.* 1996, table 3), placing the preceramic occupation in terminal Pleistocene times, exactly contemporary with the North American Paleoindian sequence from Clovis through Plainview (Figure 18 and Appendix 1) (Taylor *et al.* 1996). Statistical

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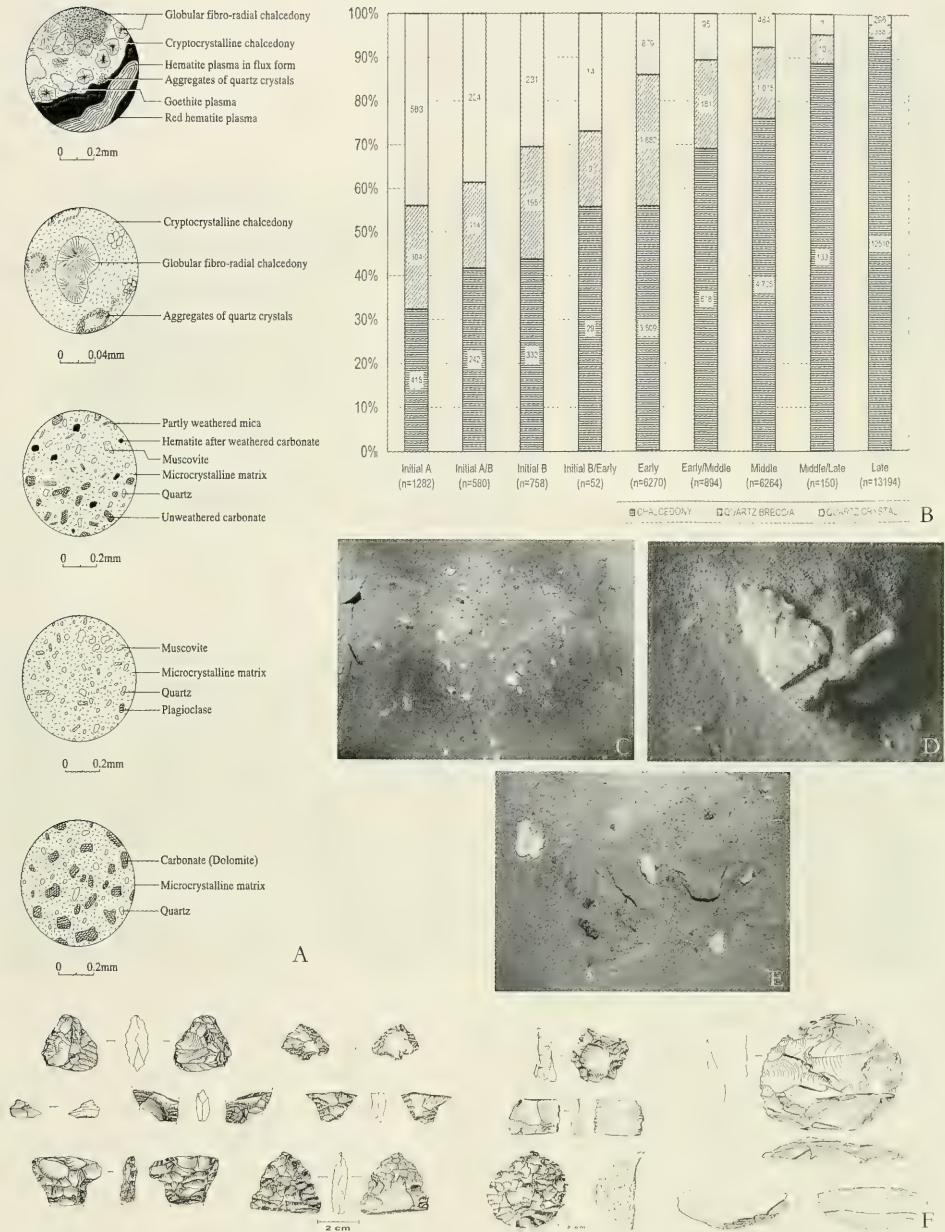


FIGURE 15. Lithic artifacts from Caverna da Pedra Pintada. A. Thin sections of chalcedony varieties. B. Histograms of raw material frequencies. C. Chalcedony debitage during excavation. D. Chalcedony point during excavation. E. Quartz crystal point during excavation. F. Drawings of lithic artifacts. By Ruth Sliva of Desert Research.

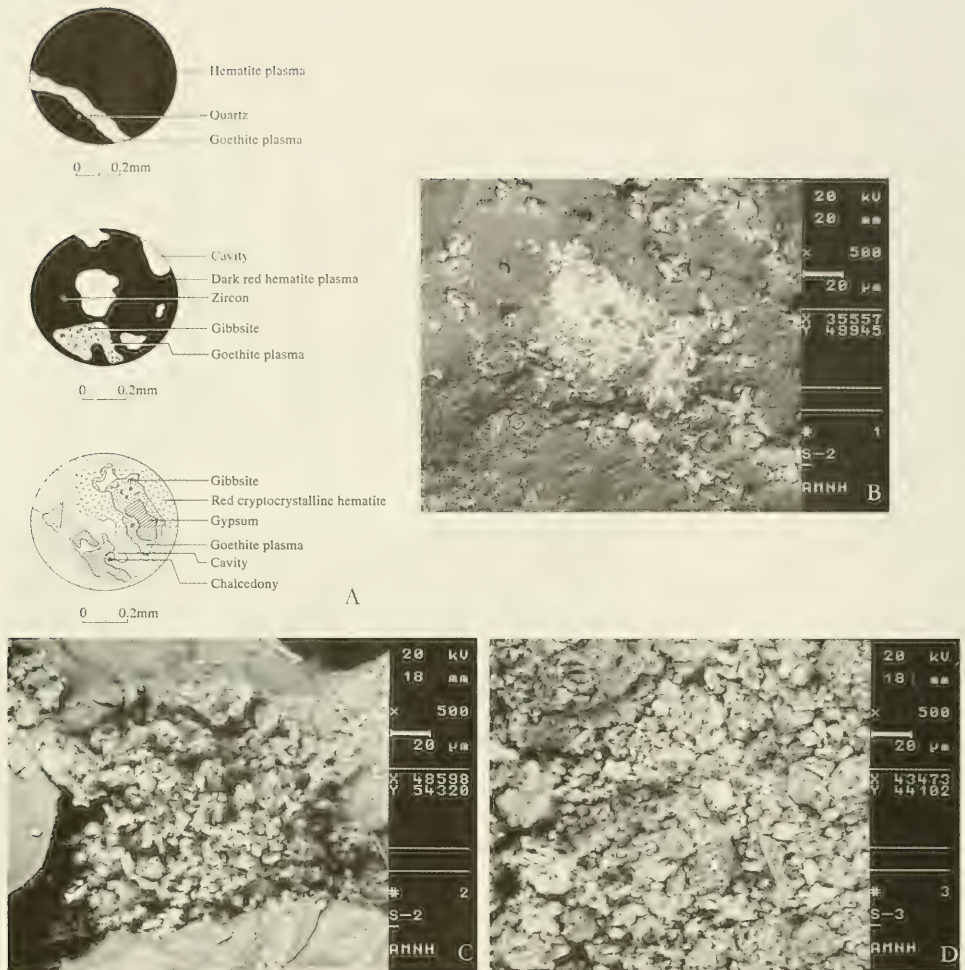


FIGURE 16. Pigment samples from Caverna da Pedra Pintada. A. Thin sections. B. Specimen 1. Microphotograph of paint from concentric cross design on north wall, (Fe/Ti ratio 8.52). C. Specimen 2. Red pigment rock, Excavation 5, Level 13, object 4, prov. 8344, plan 14, (Fe/Ti ratio 10.56). D. Specimen 3. Red paint from drops on quartz crystal debitage flake, Excavation 6, level 9, object 37, plan 11, prov. 8344, (Fe/Ti ratio 8.41). Analysis by W. Barnett, then of the American Museum of Natural History and now of the Field Museum of Natural History.

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tests established that the five phases of this Paleoindian occupation had weighted-mean radiocarbon ages significantly different from each other, in correct stratigraphic order (Roosevelt *et al.* 1997). The earliest phase, Initial A (in Stratum 17C) had eight dates: four conventional radiocarbon dates on palm endocarps and four luminescence dates on sediment and lithic artifacts. The palm seeds had been neatly cracked open for their edible kernels and burned, a pattern of usage that Amazonian zoologists recognize as distinctively human, not faunal. The Initial A dates' one-sigma error bars ranged between ± 135 and ± 310 years. These four dates were statistically the same age and had a weighted average of $11,075 \pm 106$ yr B.P. in radiocarbon years. The intercept of the mean in inter-calibrated calendar years is *ca.* 13,088 yr B.P.. From the same Initial A context, the three

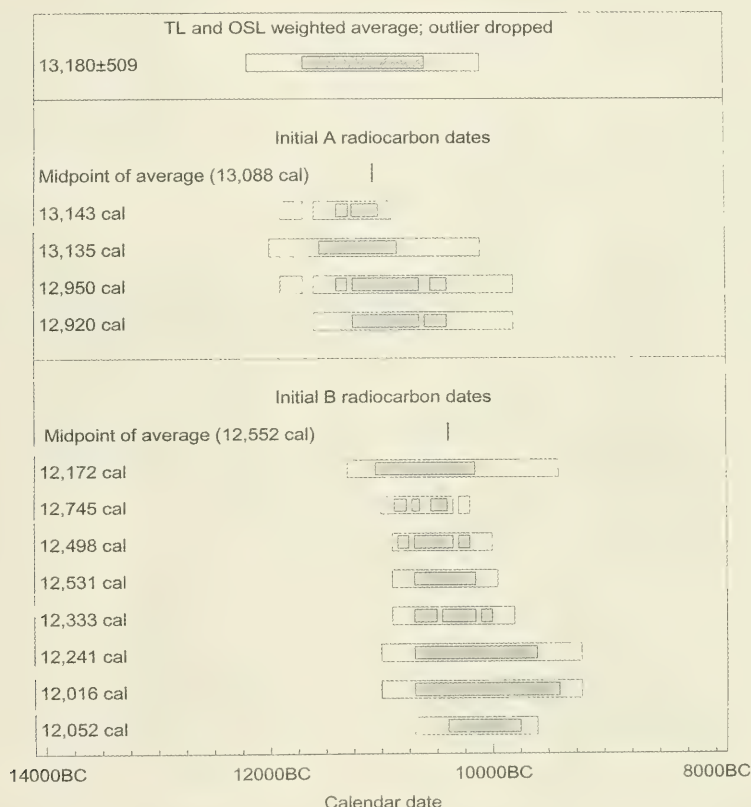


FIGURE 17. Graph of initial calibrated radiocarbon, TL, and OSL dates from Caverna da Pedra Pintada.

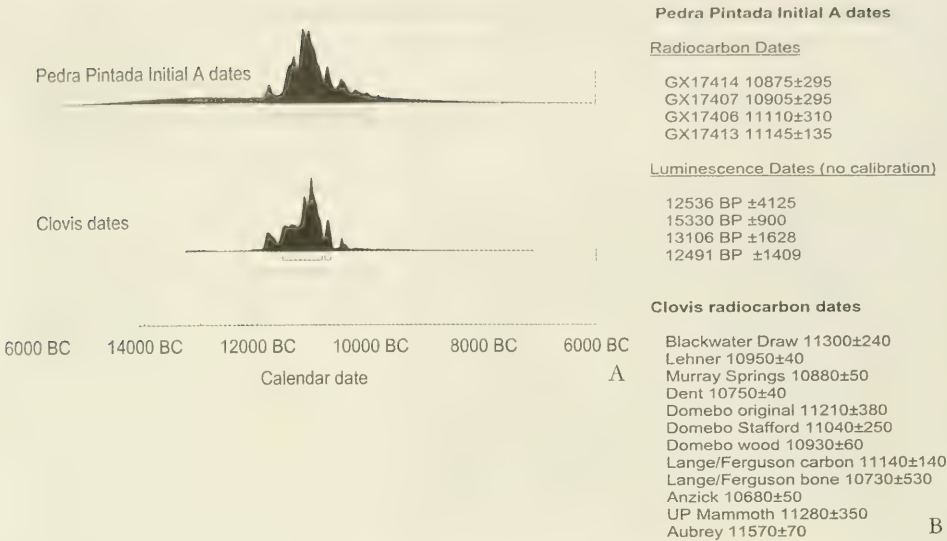


FIGURE 18. A. Graph of Initial calibrated radiocarbon, TL, and OSL dates from Caverna da Pedra Pintada compared with Clovis calibrated dates. B. Dates used to produce calibrated distribution comparison in Figure 18.

TL dates on burned lithics and one OSL date on associated sediment gave a weighted average of $13,180 \pm 509$ calendar years. The two sets of Initial A dates on biota and artifacts thus are statistically the same age as each other and significantly earlier than the weighted average of the radiocarbon dates for the subsequent preceramic occupation phase, Initial B of stratum 17B, overlying 17C. For the eleven Initial B radiocarbon dates, the weighted average is $10,420 \pm 23$ and the mean calibrated value *ca.* 12,522 yr B.P. The Initial A values are statistically the same as those for the Clovis culture; and the Initial B values are comparable to those of the Folsom culture. The preceramic foragers, therefore, arrived at the cave no later than Clovis people arrived in the southwestern United States, five thousand miles away to the north, and developed their own multiphase cultural sequence that ended about 10,000 yr B.P. Some Clovis archaeologists have objected to beginning the Monte Alegre culture at *ca.* 11,200 yr B.P., the earliest age of the Initial A phase, on the grounds that the dates are few, could be on naturally occurring objects, and have too large errors to be distinct from those of Initial B; they begin the sequence instead at *ca.* 10,500, the average date of Initial B, leaving 1000 years time for Clovis people to have descended the hemisphere to the Amazon after arrival in North America (Fiedel 1996; Haynes 1997; Reanier 1997). However, their argument implies that Clovis sites date to 11,500 yr B.P., have more dated radiocarbon samples, dates with

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smaller errors, and dates with more secure cultural context than those of Monte Alegre. But as we saw in the review of Clovis dates, 11,500 yr B.P. is neither the beginning age nor the average for Clovis, which are 11,200 and 10,900 yr B.P., respectively. In addition, the few Clovis sites with average dates of 11,000 yr B.P. or earlier have fewer site dates and much larger date errors (350 to 600 yr) than Pedra Pintada Initial A, whose largest error is only 310. Only two of these early Clovis dates are biologically identified, from cultural context, and contamination-free, unlike the four Initial A Pedra Pintada dates. In addition, the Clovis date series overlaps substantially with that of Folsom, just as Initial A dates overlap Initial B dates. Thus, eliminating the Initial A dates does not make the Monte Alegre culture younger than Clovis, for the dates they cite for Clovis would be eliminated by the same standards that they apply to Monte Alegre. When compared statistically by the same criteria, the dates of the Clovis horizon have a nearly identical age distribution as those from Pedra Pintada.

Finally, the hypothesis that Monte Alegre had to have been savanna in the Late Pleistocene was not upheld by the dated materials from Pedra Pintada. An ancient environment of tropical rainforest, lakes, and rivers for the Monte Alegre culture was confirmed by the taxonomy and carbon isotopes of the dated biological remains. Also,

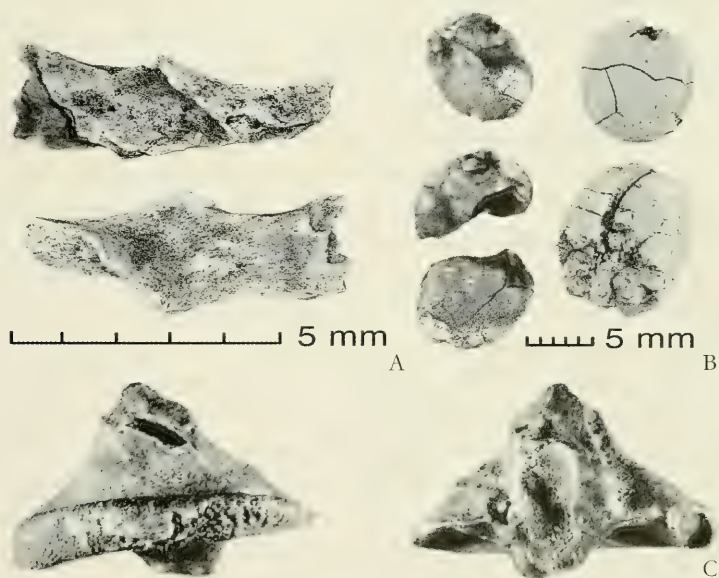


FIGURE 19. Paleoindian biological remains from Caverna da Pedra Pintada. A. Fragmentary sphe-notic bone of large fish, interior and exterior. Prov. 9243. B. Carbonized legume seeds, *Hymenaea* c.f. *parvifolia*. Prov. 9290, 9272. C. Otolith from large fish. Prov. 8347.

numerous identified taxa (Figure 19), including palm nuts, legume seeds, brazil nuts, diverse fruit pits, small and large fish bones, shellfish, turtles, tortoises, lizards, medium-sized rodents, and birds document broad-spectrum foraging of forest products, fish, and small game. Only three fragmentary bones among the several hundred preceramic specimens recovered could have come from larger fauna, of *ca.* 65 kg weight. The 56 stable carbon isotopes of the carbonized plant remains averaged *ca.* -29 per mil and ranged from -24 to -37 per mil (normalized to wood) (Appendix 1), values typical of closed canopy tropical rainforests, not of savannas or even of open forests. Thus, these early Amazonian Clovis contemporaries were tropical rainforest foragers, not specialized savanna big-game hunters.

Conclusions

The new archaeological data reviewed in this article indicate that the Clovis migration theory, which was framed when few areas but the North American high plains were well-known, is no longer viable. It is a strong blow to proponents of Clovis as the ancestral culture that no trace of terrestrial big-game-hunting, fluted-point-using, Paleoindian people have been verified along the proposed interior, upland plains route through Central and western South America. However, the accrued evidence does not replace Clovis with a much-earlier ancestor, for all the claimed pre-Clovis cultures other than Nenana in Alaska have fatal flaws under the standards of reliability. Rather, we see evidence of a near instantaneous radiation of people throughout the hemisphere soon after 12,000 years ago. The initial complexes that have come to light seem to be the first established regional adaptations, not the initial migrants to each region, so we still have not found the remains of each regional cultures' founders. Furthermore, the initial complexes have been found in just a few regions: the high plains and far north of North America and the west coast, eastern lowlands, and far south of South America. Large areas of the Americas thus remain relatively unknown archaeologically for the relevant periods, so research is needed to trace in detail the movements of the first peoples. Were there several source areas and source populations in the Old World and did people return there after establishing themselves in the New World? Did several groups with different tool cultures and ecological adaptations come in at the same time and take different routes through the hemisphere or did one group expand out and diversify in the process? We especially need to know more about the culture and lifestyle of the earliest peoples and cultures of North America. Other than Nenana in Alaska, the Clovis high plains is the only well-known area, and even this area could benefit from more precise dating and research on subsistence and artifact culture. And Central America, which must have been

the major conduit for the groups that populated South America, still has no identified initial cultures. To complete the earliest hemispheric culture history, it is a priority to make a concerted effort to identify relevant Quaternary geological features that could be surveyed for initial human sites.

At this stage, however, this much seems clear: the earliest American hunter-gatherers were not confined to cool, open, upland habitats nor to the life of specialized big-game hunting characteristic of Clovis. Their choice of habitat and subsistence mode in the different areas that they reached was eclectic and flexible. In the relatively plant-poor far north and far south of the hemisphere they focused on hunting of diverse game, supplemented by gathering. In the arid high plains of North America, they specialized in the big-game-hunting lifeway named after Clovis. In the equatorial zone, some settled the sea coast and lived mainly on fish, shellfish, and birds, and some ventured into the highlands for broad-spectrum hunting and gathering. In the eastern equatorial lowlands, in contrast, they lived by forest collecting, fishing, shellfishing, and the hunting of small game.

The emerging, though still incomplete, picture of the peopling of the Americas has implications for theories about the origins and development of the human species. The New World case suggests that, contrary to the assumptions of Optimal Foraging Theory, the Upper Paleolithic big-game-hunting lifeway was not a primeval adaptation (Beaton 1991), but rather a late and specialized local adaptation by people coming into temperate habitats from the tropical and subtropical zones of Africa. Revisions of our understanding of the history of environments and human ecology in Africa (Bonnefille 1995; Roosevelt n.d.c) suggests that our species arose and developed not in adaptation to specialized big-game hunting in savannas but rather in generalized foraging along the rivers and lakes of humid tropical forests in sub-Saharan Africa. In fact, the African botanical evidence suggests that the savanna woodlands of sub-Saharan Africa are a much later anthropogenic climax (Lovett 1993), rather than an Ice-Age environmental climax that was the hearth of the species. Recent reviews of paleoanthropological data from Africa cast doubt on the evidence for specialized big-game hunting during the early Paleolithic, when our genus was emerging (Klein 1999). Evidently, future research on the Plio-Pleistocene history of humans will need to forge new understandings of the relationship of ecology and social development in human evolution. Big-game hunting was the core activity around which early human social organization was supposed to have been organized. If broad-spectrum foraging, not big-game hunting, was the preferred adaptation of humans during much of the Pleistocene, then models of early human social interaction and evolutionary explanations of human nature will need to be revised.

Abstract

Early in research on the peopling of the Americas, Clovis big-game hunters of the northern high plains seemed sure to be the first people who colonized the Americas. Anthropologists believed that Clovis hunters had rapidly colonized the hemisphere from Alaska to Patagonia in only a thousand years from 12,000 to 11,000 years ago. Thought to have followed the big herd game through their grazing lands — the North American high plains and the cool, arid uplands of Central and South America — they avoided the seacoasts on both sides of the continent and also the game-poor, disease-ridden tropical rainforests of eastern Central America and South America.

Systematic investigations at both old and new Paleoindian sites have changed the picture of the migrations and adaptations of the first Americans. Although some researchers had dreamed of more ancient, pre-Clovis cultures from 12,000 to 30,000 years ago, the evidence for them has failed most criteria of reliability: consistent date series lacking contamination from geological carbon, documented cultural remains, and comparable finds at several sites. Re-evaluation of evidence also has pushed Clovis younger than had been thought, no earlier than about 11,100 to 10,800 yr B.P. Alaska still has the earliest solidly dated and investigated cultures in a range from 11,800 to 11,000 yr B.P., but these cultures are broad-spectrum hunter-gatherers not resembling Clovis greatly in tool culture or ecological adaptation. Excavations at new sites and continued work at old ones have changed the picture in South America as well, revealing a lack of a Clovis horizon. Even supposed Clovis descendants at the tip of South America turn out to be the same age as Clovis, and their subsistence was small-game, not large-game, hunting. New sites reveal the existence of coastal fishers and tropical rainforest foragers as old as Clovis hunters and culturally distinct from them. This new evidence on the colonization reveals the evolution of more diverse Ice-Age ecological and cultural adaptations than previously suspected, raising new questions for research on human origins.

Endnotes

¹ Dates in our article are given in uncalibrated radiocarbon years before the present (1950) unless otherwise noted.

² Many researchers attach the word Clovis to any thin, vaguely parallel-sided, undated points and then assert that such points must therefore be 11,500 years old, due to their equation with Clovis points (*e.g.*, McAvoy & McAvoy 1997:169, figure 5.67–8; Morrow & Morrow 1999; Sassaman 1996:79, figure 4.11). It also is common to use the word “fluted” for points even when there are no basal channel flakes, but only broad thinning-flake scars invaded by pressure edge-trimming (*e.g.*, Frison 1991:70, figure 2.34; Morrow & Morrow 1999; Borrero & McEwan 1997:40, figure 23). The nature of the lithics in validated Clovis sites also has been confused in the literature by the characterization of very

finely flaked points from undated caches to the Clovis culture on the assumption that the finest points have to be Clovis (Frison & Bradley 1999). In many cases, however, the undated points in question actually show flaking customs found in late Paleoindian complexes (*e.g.*, Frison & Stanford 1982), not in documented and dated Clovis assemblages (Hester *et al.* 1982; Leonhardy 1966). Such usages are problematic at multiple levels. A point the age of Clovis would be between 11,200 to 10,800, not 11,500 yr B.P. Furthermore, parallel-sided points continue long after the time of Clovis in many North American regions (Anderson *et al.* 1996:10, figure 1.2; Frison 1991; Morse *et al.* 1996), so an undated point of this shape could be as recent as 8000 years ago. Points with very fine parallel, overshoot thinning are found in many Paleoindian and Early Archaic cultures. Attributing such points to Clovis has created a Clovis horizon without a secure chronological basis.

³ Most researchers use Paleoindian as a chronological term referring to the peoples and cultures who initially colonized the New World in the terminal Pleistocene, before *ca.* 10,000 years ago. Some others use the term only for Clovis big-game, fluted-point, spear-hunters and their presumed descendants, using the term Archaic for broad-spectrum foragers with the triangular points. However, since these two terms were first used for a presumed chronological sequence, and since the triangular point foragers have now turned out to be contemporary with Clovis, the latter usage is confusing.

⁴ For the period of early Paleoindian occupations, there is as yet no tree-ring calibration curve, so the correction factor is estimated from the difference between radiocarbon and uranium/thorium dates on the same coral samples (Taylor *et al.* 1996). Thus, the corrected ages for the early dates are not necessarily more accurate than the uncorrected radiocarbon ages at this point in dating technology. Intercalibration of the earliest *reliable* Clovis beginning dates on identified cultural carbon from documented stratigraphic contexts is about 13,000 calendar years, and the majority of Clovis dates calibrate at about 12,900 or less (see Appendix 1).

⁵ The presence of pre-Clovis complexes in northeastern sites is commonly inferred in the following manner. A "Clovis" level is defined, due to the presence of parallel-sided bifaces so undiagnostic that actually could be any Paleoindian or Archaic phase. Any lithic find occurring below that level is defined as pre-Clovis. The association of primarily or entirely late Paleoindian or Archaic dates with these lithic levels does not deter the interpreters from inferring a pre-Clovis phase (*e.g.*, McAvoy & McAvoy 1997:22–190).

⁶ The Taima Taima site area has been exploited for petroleum, a possible source of too-old carbon there; I myself, observed wells pumping there in 1994.

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APPENDIX 1

*Dates From High Plains Clovis Sites**

The Clovis Site, Blackwater Draw Locality 1, Clovis, NM

Weighted average of three dates on three samples: $11,300 \pm 240$ yr B.P. (13,180 cal)

The dates from the eponymous Clovis site fail five of the seven reliability criteria. They have too-large error bars, are on material vulnerable to contamination by too-old carbon, are on noncultural carbon, and lack of secure cultural association. In the regional sequence, they average 300 yr earlier than dates from sites with high reliability scores.

The context was interpreted as a kill or scavenging site. The material dated was humic acid and lignin from pooled fragments of naturally carbonized water plants. The amino acids of bones of mammoth prey could be dated by current AMS methods but have not been so far. Abundant calcareous rocks and their solutes are local geological carbon sources for uptake by water plants and for post-depositional diagenesis. Sample sizes were too small for stringent cleaning, and the error bars range from 350 to 500 yr. The series is in reversed sequence but is internally consistent because of the large error ranges.

$11,630 \pm 400^{**}$ (A491) (13,773, 13,722, 13,504 cal) From cranium of slain mammoth in bone bed, El Lano dig I, from "grey sand" strata disturbed by nearby artesian spring chimney. Cultural associations of Clovis artifacts with this mammoth noted but not documented with detailed plots, distribution tables, or full illustrations.

$11,170 \pm 350^{**}$ (A481) (13,148 cal) From pre-cultural "grey sand" layer *ca.* 0.5 m below bone bed. No cultural associations documented.

$11,040 \pm 500^{**}$ (A490) (13,013 cal) From pre-cultural "grey sand" strata *ca.* 1.0 m below bone bed. No cultural associations documented.

Lebner, AZ

Weighted average of 12 dates on 12 samples: $10,950 \pm 40$ yr B.P. (12,980 cal)

The dates fulfill all but two reliability criteria and are consistent with each other and with reliable dates from other Clovis sites. However, the samples were aggregates of dispersed charcoal, and charcoal is subject to the old-wood problem.

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Lehner is interpreted as a kill site (Haury *et al.* 1959). The samples were associated with megafaunal bone and artifacts. The sample material is problematic: pooled aggregates of botanically-unidentified charcoal fragments dispersed in the bone bed. All the dates have the old wood charcoal problem. All sample sizes were adequate and all errors acceptable. The series is internally consistent and matches high reliability dates from other Clovis sites.

11,470 $\pm$ 110 (SMU308) (13,444 cal)
11,170 $\pm$ 200 (SMU264) (13,148 cal)
11,080 $\pm$ 230 (SMU196) (13,125, 13,083, 13,031 cal)
11,080 $\pm$ 200 (SMU181) (13,125, 13,083, 13,031 cal)
10,950 $\pm$ 110 (SMU194) (12,980 cal)
10,950 $\pm$ 90 (SMU290) (12,980 cal)
10,940 $\pm$ 100 (A378) (12,976 cal)
10,860 $\pm$ 280 (SMU164) (12,911 cal)
10,770 $\pm$ 140 (SMU168) (12,880 cal)
10,710 $\pm$ 90 (SMU340) (12,847 cal)
10,700 $\pm$ 150 (SMU297) (12,839 cal)
10,620 $\pm$ 300 (SMU347) (12,807, 12,725, 12,659 cal)

Murray Springs, AZ

Weighted average of eight dates on eight samples: 10,880 $\pm$ 50 yr B.P. (12,923 cal)

As at Lehner, the large date series fulfills all but two criteria: the preference for individual specimen-samples and freedom from old-wood effects. The series is consistent internally and with the reliable date series from other Clovis sites.

The site was interpreted as a kill site. The dated material was associated with megafaunal bone and artifacts. The dated material was pooled aggregates of dispersed, botanically unidentified wood charcoal flecks, which present potential old wood problems. The samples were associated with artifacts and prey-animal bone in the bone bed. Only one of eight dates has too-large error bar. All in the series are the same statistical age, consistent with reliable dates from other Clovis sites.

11,190 $\pm$ 180 (SMU18) (13,153 cal)
11,150 $\pm$ 450** (A805) (13,144 cal)
11,080 $\pm$ 180 (Tx1413) (13,125, 13,083, 13,031 cal)
10,930 $\pm$ 170 (Tx1462) (12,970 cal)
10,890 $\pm$ 180 (SMU27) (12,933 cal)

10,840 $\pm$ 140 (SMU42 (12,902 cal)

10,840 $\pm$ 70 (SMU41) (12,902 cal)

10,710 $\pm$ 160 (Tx1459) (12,847 cal)

Dent, CO

Weighted average of six dates on two samples: 10,750 $\pm$ 40 yr B.P. (12,873 cal)

The dates from the Dent, Colorado, site fulfills some of the dating reliability criteria but fails several. Scholars disagree about whether the mammoth represents a human site, and the stratigraphic context has given both infinite and recent dates indicating redeposition and potential old carbon effects.

The site is a probable kill, but it has been argued that the mammoth may not have been associated with the Clovis lithics present. The Clovis-age dates were on two samples of mammoth bone. The sample with the oldest date (I622) was too small and gave too-large error bars. The other sample was adequate (AA 2941 to 2947) and gave acceptable error bars. Geological contamination from coal is documented. The purified bone series is consistent internally but falls in the younger range of reliable dates from other Clovis sites.

32,260 $\pm$ 2100** (SMU 120) lignite from the same matrix as the mammoth bone

170 $\pm$ 50 (SMU 121) charcoal from the same matrix as the mammoth bone

11,200 $\pm$ 500** (I622) (13,155 cal) mammoth bone bulk, unpurified organic acids

10,980 $\pm$ 90 (AA2941) (12,992 cal) XAD purified hydrolysate from mammoth bone

10,660 $\pm$ 170 (AA2942) (12,820, 12,709, 12,676 cal) aspartic acid from same

10,800 $\pm$ 110 (AA2943) (12,889 cal) hydroxyproline from same

10,600 $\pm$ 90 (AA2945) (12,800, 12,731, 12,652 cal) hydroxyproline from same

10,710 $\pm$ 90 (AA2946) (12,847 cal) glycine from same

10,670 $\pm$ 120 (AA2947) (12,824, 12,704, 12,682 cal) alanine from same

Domebo, OK

Weighted average of seven dates on four samples: 10,944 $\pm$ 59 yr B.P. (12,978 cal)

The dates fulfill most criteria, but the samples were small, date all very large, and contaminants were present. However, the series is consistent internally and matches reliable date series from other Clovis sites.

This is a mammoth kill site in a stream. Samples listed here are all that came from the bone bed. They were associated with projectile points. The dates were run on bone or

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on noncarbonized wood, the different materials providing a cross-check on dating reliability. [Some wood samples listed in earlier sources were not from the occupation site.] The bone was taxonomically identified but not the wood. The contaminants limestone and petroleum were both present in the drainage. Bone A was not purified to individual amino acids and so could be affected by contaminants; the other bone sample was purified to amino acids considered free from contamination. The bone dates are often referred to as evidence for a pre-11,200 yr B.P. age of Clovis, but all were on samples inadequate in size and thus have very large error bars from 450 to 600 yr. Only the two wood samples were adequate size and gave small error bars. (Whether they were individual pieces or if aggregates were dated is not specified.) All the dates are statistically consistent and average in the range of reliable dates from other Clovis sites.

11,220 $\pm$ 500** (SI172) (13,159 cal) bulk unpurified organic acids from mammoth bone A

11,200 $\pm$ 600** (SI175) (13,155 cal) humic acids from same

11,480 $\pm$ 450** (AA825) (13,448 cal) XAD hydrolysate from different mammoth bone

10,860 $\pm$ 450** (AA811) (12,911 cal) pro-hydro from same

10,810 $\pm$ 420** (AA805) (12,892 cal) XAD hydrolysate from same

11,010 $\pm$ 85 (AA12533) A (13,002 cal) botanically-unidentified wood specimens from bone bed (soil stratum C2)

10,845 $\pm$ 90 (AA13028) B (12,904 cal) botanically-unidentified wood specimens from bone bed (soil stratum C2)

Lange-Ferguson site, SD

Weighted average of two dates on two samples: 11,100 $\pm$ 160 yr B.P.

The dates have low scores on all reliability criteria but one. Sample materials were undesirable: pooled botanically-unidentified dark bits and unpurified mammoth bone organic matter. Cleaning procedures were not as rigorous as is possible at present. There were only two dates, and one has a too-large error. Samples were not piece plotted, and no detailed report published. The only positive criteria are that the dates are statistically the same age and fit within the range of highly reliable date series from Clovis sites.

11,140 $\pm$ 140 (AA905) (13,142 cal) pooled aggregates of dispersed, botanically unidentified carbon flecks

10,730 $\pm$ 530** (I13104) (12,864 cal) mammoth bone bulk, unpurified organic acids

*Anzick, MT**Weighted average of three dates on one sample: $10,831 \pm 56$ yr B.P.*

The five dates fulfill four of seven reliability criteria. The earliest three are internally consistent, and the latest two are internally consistent, but the two groups are not consistent with each other. Clovis archaeologists accept the earliest three, not the later two. All the dates have small error-bars, and all were on adequate samples of a human bone. The purified amino acids that were dated are not considered subject to carbon contamination. Nevertheless there was only one bone sample from the relevant burial, and the burial was not directly associated with artifacts. The burial site, uncovered during construction, was not excavated and documented scientifically. Another skeleton at the site gave Holocene, not Pleistocene dates. This age difference and the lack of directly associated diagnostic Clovis cultural materials in a multicomponent site means that the culture of the earlier dated skeleton is not established.

- 10,940 $\pm$ 90 (AA2981) (12,976 cal) glycine from purified human bone
- 10,820 $\pm$ 100 (AA2979) (12,896 cal) glutamic acid from same
- 10,710 $\pm$ 100 (AA2980) (12,847 cal) hydroxyproline from same
- 10,370 $\pm$ 130 (AA2982) (12,323 cal) alanine from same
- 10,240 $\pm$ 120 (AA2978) (11,950, 11,786, 11,783 cal) aspartic acid from same

*Colby, WY**Weighted average of two dates on two samples: $10,960 \pm 120$ yr B.P.*

The dates fulfill two of the seven reliability criteria. The site was a possible kill and meat storage site. Dates were on unpurified mammoth bone components and thus subject to contamination. They are not the same date statistically, a problem since the site was not a long-term, sequential occupation. However, the site was scientifically excavated and published. Projectile points were present, although their base forms are unusual ones for Clovis. Both dates have acceptable error bars and fall in the range of reliable dates from Clovis sites.

- 11,200 $\pm$ 220 (RL392) (13,155 cal) bulk, unpurified collagen from mammoth bone
- 10,864 $\pm$ 141 (SMU254) (12,913 cal) apatite from mammoth bone

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UP Mammoth site, WY

No weighted average because only a single date was available.

The date only meets one of the seven criteria of reliability. It is from a possible mammoth-kill site, but the human presence has been disputed by Clovis archaeologists, and there were no directly associated human materials. The date was on a bulk, unpurified bone sample and thus subject to contamination. It has a too-large error bar and is slightly older than the series of high reliability dates from Clovis sites.

11,280 $\pm$ 350** (I449) (13,174 cal) bulk, unpurified organic acids from mammoth tusk

Goshen Culture

Mill Iron, MT

No weighted average possible due to statistical inconsistency of associated dates.

The site fails six of the seven reliability criteria. The site was a kill site made up of a bison bone bed and adjacent campsite. The dates from both contexts were internally inconsistent although the material seemed contemporary culturally. The excavator reported that there was lignite coal in the deposits, and a dating lab found that one sample was made up primarily of the lignite. Although the excavator stated that the carbon contamination and statistical inconsistency of the series do not present a problem for the chronology, the dates are indeed problematic. They were on aggregations of botanically-unidentified dispersed samples. They have one old-wood problem, if they are indeed charcoal. The samples have a documented association with a second, much older geological carbon contaminant, lignite, and the lignite was found mixed with charcoal in one sample. The associated projectile points show stylistic and technological features characteristic of later Paleoindian cultures such as Agate Basin, rather than the early Paleoindian Clovis and Folsom cultures. The dates thus do not match the dates expected for the cultural material. In the future, the age of the site could be verified by dates on purified amino acids from the bison bone in the bed.

23,720 $\pm$ 220 (AA-3668) "charcoal" sample composed predominantly of lignite coal from Cretaceous Hell Creek Formation

11,570 $\pm$ 170 (NZA 625) (13,480 cal) bison bone bed

11,560 $\pm$ 920** (NZA 624) (13,477 cal) bison bone bed

11,360 $\pm$ 130 (Beta 20111) (13,241 cal) camp, processing area
 11,340 $\pm$ 120 (Beta 13026) (13,258 cal) camp, processing area
 11,320 $\pm$ 130 (Beta 16179) (13,279 cal) camp, processing area
 11,010 $\pm$ 140 (Beta 16178) (13,002 cal) camp, processing area
 10,990 $\pm$ 170 (NZA 623) (12,995 cal) bison bone bed
 10,770 $\pm$ 85 (AA 3669) (12,880 cal) bison bone bed
 10,760 $\pm$ 130 (Beta 20110) (12,876 cal) camp, processing area

Culture Undetermined

Aubrey, TX

Weighted average of two dates on two samples: 11,570 $\pm$ 70 yr B.P. (13,480 cal)

The dates fail to meet six of the seven dating criteria. There are only two dates. They were run on small samples made up of aggregates of botanically-unidentified, dispersed carbon bits. The two samples' unit-level stratigraphic sections, specific lithic associations, and specific stable carbon isotope measurements have not been published. No fluted Clovis points were reported from Trench B, from which the date samples came. The samples are from a disturbed geological context consisting of a disconformity on an erosion surface at the interface of Stratum G, a 10,900 to 7,600 yr B.P. carbonate-rich flood-plain deposit, with Stratum A, a 25,000 to 15,000 yr B.P. alluvial deposit from stream beds cut in Cretaceous bedrock. The samples thus had potential contact with several potential older contaminants including carbonate, Cretaceous lignite, peat, and animal bone. A Clovis age-geological deposit was not found at the locality, suggesting that the cultural component is a later Paleoindian culture deposited into the post-Clovis geological Stratum G.

11,590 $\pm$ 90 (AA-5274) (13,488 cal)
 11,540 $\pm$ 110 (AA-5271) (13,470 cal) unidentified carbon aggregates

*(Damon & Long 1962; Damon *et al.* 1964:93–98; Damon *et al.* 1966:100–101; Ferring 1989; 1994; Frison 1991:25, 39, 41, 1996; Frison & Todd 1986; Hannus 1990; Haury *et al.* 1959, figure 16; Haynes 1987, 1992, 1997; Haynes *et al.* 1966, 1967; Haynes *et al.* 1998; Humphrey and Ferring 1994; Taylor *et al.* 1996; Leonhardy 1966; Hester *et al.* 1972:174–176; 225, figure 130; Roosevelt 1998a; Stafford *et al.* 1987; Stafford 1990;

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Stuiver *et al.* 1998a. Weighted averages calculated by Linda Brown and John Douglas, using CALIB.)

**indicates a too-large error.

Initial A and B calibrated radiocarbon and calendar TL and OSL dates from Pedra Pintada cave, Monte Alegre culture.

The radiocarbon dates fit all the reliability criteria, and the TL/OSL dates fit all but one. The carbon samples were individual pieces of identified carbonized palm or tree fruits, wood charcoal chunks, lithic artifact fragments, or localized sediment samples. (Although Clovis archaeologists have suggested that the initial A fruit seeds could be food remains of animals, these seeds are identical in nature to the seeds of the later Monte Alegre phases in higher strata, whose dates they accept, and such carbonized seeds are judged by Amazon zoologists to be evidence of human, not animal, subsistence.) Chemical tests for solid and soluble contamination were negative. All radiocarbon errors were within acceptable error ranges, unlike many Clovis dates. All TL/OSL errors were larger than acceptable for radiocarbon but typical for these techniques. All samples were from specific, mapped localities during excavation. Although Clovis archaeologists also suggested that there are too few dates for Initial A, this phase has four radiocarbon dates, more than many Clovis sites have. The associated dates on different materials fall statistically in the same ranges. The radiocarbon series from each phase is statistically consistent internally, and the weight averages of the carbon dates of the two phases differ significantly. The weight averages of the calibrated radiocarbon dates and the accepted calendar TL/OSL dates are statistically consistent. (The earliest TL date, 16,190 yr B.P., was rejected for inconsistency with the rest of the series.) The radiocarbon range also is consistent statistically with the reliable dates from other eastern Brazilian sites with similar cultural and biological materials.*

TL/OSL Initial A

8231SW base, object 2 next to hearth

TL of burned chalcedony bifacial reduction flake (outlier, rejected) (16,190 $\pm$ 930 cal)**

8346 base, object 1

TL of burned chalcedony bifacial reduction flake 15,330 $\pm$ 900 cal**

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8231W, hearth

OSL of sediment $13,106 \pm 1628$ cal**

8231SE hearth, object 18

OSL of heavy fraction of sediment $12,536 \pm 4125$ cal**

8231CE general level

OSL of sediment $12,491 \pm 1409$ cal**

**Weighted average of four dates on four samples: $13,180 \pm 509$ calendar yr B.P.

TL/OSL
Initial B

8231 far SW, top, object 1

TL of burned brecciated quartz flake $11,880 \pm 760$ cal**

Radiocarbon
Initial A

8314CW, base, hearth, object 4

carbonized sacuri endocarp $11,145 \pm 135$ (GX-17413) 13,143 cal

8231W base, hearth, object 17

carbonized tucuma endocarp $11,110 \pm 310$ (GX-17406) 13,135 cal

8231SE base, hearth, object 18

carbonized tucuma endocarp $10,905 \pm 295$ (GX-17407) 12,950 cal

8314C base, object 5

carbonized tucuma endocarp $10,875 \pm 295$ (GX-17414) 12,920 cal

Weighted average of four dates on four samples: $11,075 \pm 106$ 13,123, 13,088, 13,028 cal

Radiocarbon
Initial B

9290

carbonized jutai seed $10,683 \pm 80$ (NZA9898) 12,954–12,681 cal

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8345 object 4
 carbonized tucuma endocarp $10,655 \pm 285$ (GX-17420) 12,712 cal
 8231CW top, object
 carbonized sacuri endocarp $10,560 \pm 60$ (B6952CAMS) 12,745 cal
 8231 CW top, object
 wood charcoal fragment $10,450 \pm 60$ (B76952CAMS) 12,498 cal
 9274 object 13
 humate from GX-19537CAMS $10,470 \pm 70$ (GX-19537CAMS) 12,387 cal
 9274 object 5
 carbonized sacuri endocarp $10,410 \pm 60$ (GX-19538CAMS) 12,531 cal
 8314SW top, object 6
 carbonized sacuri endocarp $10,392 \pm 78$ (GX-17400CAMS) 12,333 cal
 9274 object 5
 humate from GX-17400CAMS $10,390 \pm 70$ (GX-19538CAMS) 12,332 cal
 9274 object 6
 humate from sacuri endocarp $10,360 \pm 70$ (GX-19536CAMS) 12,203 cal
 8346 object 1
 carbonized sacuri endocarp $10,305 \pm 275$ (GX-17422) 12,241 cal
 8345 object 13
 carbonized sacuri endocarp $10,275 \pm 275$ (GX-17421) 12,016 cal
 8345
 carbonized achua endocarp $10,261 \pm 62$ (NZA9897) 12,355–11,808 cal
 9274 object 13
 carbonized sacuri endocarp $10,250 \pm 70$ (GX-19537CAMS) 12,052 cal
 Weighted average of 12 dates on 11 samples: $10,420 \pm 23$ yr B.P. 12,582, 12,522,
 12433 cal

TL/OSL
Initial A

8231SW base, object 2 next to hearth
 TL of burned chalcedony bifacial reduction flake (outlier, rejected) $(16,190 \pm 930)$ cal
 8346 base, object 1
 TL of burned chalcedony bifacial reduction flake $15,330 \pm 900$ cal
 8231W, hearth
 OSL of sediment $13,106 \pm 1628$ cal
 8231SE hearth, object 18

ROOSEVELT, DOUGLAS AND BROWN

OSL of heavy fraction of sediment $12,536 \pm 4125$ cal

8231CE general level

OSL of sediment $12,491 \pm 1409$ cal

Weighted average of five: $13,180 \pm 509$ calendar yr B.P.

Initial B

8231 far SW, top, object 1

TL of burned brecciated quartz flake $11,880 \pm 760$ cal

Radiocarbon
Initial A

8314CW, base, hearth, object 4

carbonized sacuri endocarp $11,145 \pm 135$ (GX-17413) 13,143 cal

8231W base, hearth, object 17

carbonized tucuma endocarp $11,110 \pm 310$ (GX-17406) 13,135 cal

8231SE base, hearth, object 18

carbonized tucuma endocarp $10,905 \pm 295$ (GX-17407) 12,950 cal

8314C base, object 5

carbonized tucuma endocarp $10,875 \pm 295$ (GX-17414) 12,920 cal

Weighted average of four: $11,075 \pm 106$ 13,123, 13,088, 13,028 cal

Initial B

9290

carbonized jutai seed $10,683 \pm 80$ (NZA9898) 12,954–12,681 cal

8345 object 4

carbonized tucuma endocarp $10,655 \pm 285$ (GX-17420) 12,712 cal

8231CW top, object

carbonized sacuri endocarp $10,560 \pm 60$ (B6952CAMS) 12,745 cal

8231 CW top, object

wood charcoal fragment $10,450 \pm 60$ (B76952CAMS) 12,498 cal

CLOVIS AND PRE-CLOVIS VIEWED FROM SOUTH AMERICA

9274 object 13
humate from GX-19537CAMS $10,470 \pm 70$ (GX-19537CAMS) 12,387 cal
9274 object 5
carbonized sacuri endocarp $10,410 \pm 60$ (GX-19538CAMS) 12,531 cal
8314SW top, object 6
carbonized sacuri endocarp $10,392 \pm 78$ (GX-17400CAMS) 12,333 cal
9274 object 5
humate from same $10,390 \pm 70$ (GX-19538CAMS) 12,332 cal
9274 object 6
humate from sacuri endocarp $10,360 \pm 70$ (GX19536CAMS) 12,203 cal
8346 object 1
carbonized sacuri endocarp $10,305 \pm 275$ (GX-17422) 12,241 cal
8345 object 13
carbonized sacuri endocarp $10,275 \pm 275$ (GX-17421) 12,016 cal
8345
carbonized achua endocarp $10,261 \pm 62$ (NZA9897) 12,355–11,808 cal
9274 object 13
carbonized sacuri endocarp $10,250 \pm 70$ (GX-19537CAMS) 12,052 cal

Weighted average of 11: $10,420 \pm 23$ yr B.P. 12,582, 12,522, 12,433 cal

*Haynes 1997; Hemmings 1970; Pessis 1999; Prous 1980–81, 1986a and b, 1991, 1995, 1999; Reanier 1997; Roosevelt 1998a, b, 2000a, 2000d, 1999; Roosevelt *et al.* 1996; Roosevelt *et al.* 1997.

**indicates a too-large error

CHAPTER EIGHT

PLANT FOOD AND ITS IMPLICATIONS FOR THE PEOPLING OF THE NEW WORLD: A VIEW FROM SOUTH AMERICA

Tom D. Dillehay and Jack Rossen



In recent years, it has become clear that without the important adaptations that took place among Late Pleistocene foragers in many parts of the Americas, the subsequent development of more complex human societies and food production would have been impossible. Whatever the causes and wherever the centers of plant domestication, these developments had their roots in decisions made by Late Pleistocene foragers to settle in forested and wetland environments, for instance, and to restructure their subsistence patterns to exploit more plant foods, transport them to new environments, and perhaps to consciously manipulate them to the benefit of people. Although early foragers probably always procured wild plants, the most important period may be in post-glacial times, between 13,000 and 10,000 years ago depending upon geography, when different climatic conditions, vegetation, and animal life were established in the Americas.

Due to a series of recent archaeological discoveries in North America and South America, many aspects of the initial peopling of the New World are under closer scrutiny. New data from early sites in Alaska, Pennsylvania, South Carolina, and Virginia in the north and Argentina, Brazil, Chile, and Peru in the south offer challenging fresh insights on when people first came to the New World, where they came from, and the kinds of technologies and economies they practiced. Until recently, the study of Pleistocene archeology focused primarily on tracking the movement of hunters (mainly Clovis people) as food resources were depleted due to climatic change, human population growth, and/or overexploitation. To put it simply, most archeologists studied unchanging hunters in changing environments (*cf.*, Martin 1973; Haynes 1969; Fagan 1987; Carlisle 1988; Meltzer 1993, 1997; Dillehay *et al.* 1993), and saw technological and economic adjustments primarily as adaptive reactions to climatic changes. No doubt, these changes created new opportunities and imposed new constraints on, and opportunities for, humans everywhere.

Most exciting in recent years has been a greater recognition of widespread technological and economic diversity throughout the Americas. People not only hunted, but they also exploited a wide array of plant foods and, in coastal areas, marine foods. This diversity probably relates to a greater time depth of humans in the New World than was previously recognized and thus more ancient opportunities to develop different local traditions and more cultural complexity. We know that cultural diversity in South America was widespread by at least 10,500 yr B.P. (Bryan 1973, 1978, 1986; Ardila & Politis 1989; Dillehay *et al.* 1993; Dillehay 1999).

Archaeologists have identified big-game hunting as a fundamental subsistence activity of many first Americans, because early sites contain stone tools (especially projectile points) and the bone remains of extinct animals. Organic remains other than animal bones have not been preserved in sites or have not been found by archeologists due to inadequate recovery techniques. For instance, plant remains are easily overlooked if water flotation is not conducted, but they appear in surprising quantity and diversity when flotation is included in the excavation and analysis strategy (Dillehay 1989; Rossen *et al.* 1996; Dillehay *et al.* 1997; Ramirez 1989). As a result, archeologists have underestimated the role of plant foods in early diets, especially in wetland and wooded environments where a high density and diversity of plant foods are usually found (*e.g.*, Richardson 1978; Meltzer & Smith 1986; Dillehay 1986; Meltzer 1993). Examples are the Monte Verde site in the cool, temperate rainforest of southern Chile, the Las Vegas site in southeastern Ecuador, sites on the north coast of Peru, and several rockshelter sites in the tropical forests of eastern Brazil (Figure 1). Other examples may be at Guitarrero Cave (Lynch 1981) and Tres Ventanas (Engel 1970) in the Peruvian highlands and other rockshelter sites in the Andes. At these sites, in addition to animal remains, a wide variety of culturally selected plant parts were recovered through a combination of good preservation and the application of a specialized water-flotation technique. The preservation and technique permitted the use of direct evidence of food and non-food items to reconstruct the resource base of the paleoenvironment of the site's inhabitants, and to infer the diet, residential status and social organization. It was, after all, human exploitation of plants in Late Pleistocene times that set the stage for later plant domestication in many areas of the New World. As we employ more sophisticated plant recovery techniques and find new sites in different environments, it will become clearer that there are a wide range of generalized stone tool industries (particularly unifacial industries) and economies in early sites throughout the New World (Bryan 1973; Dillehay *et al.* 1993; Dillehay 1999). We expect to find these sites in "food affluent" environments that contained a great bulk and high diversity of usable plant biomass, such as wetlands and forests. Within wetlands, whether they are swamp, mangroves, marsh, fen or bog, salt-

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FIGURE 1. Of South America showing countries, major river systems, and some areas discussed in the text: 1) Monte Verde site in Chile; 2) Talara area on the north coast of Peru; 3) Las Vegas site in southwest Ecuador; 4) savanna and forested plains in highland Colombia and 5) eastern Brazil; and 6) Nanchoc area on the north coast of Peru.

water or freshwater, lives a wide array of wildlife unseen in other environments. Ethnographers and archaeologists have observed that most semisedentary to sedentary hunter-gatherer groups with broad-spectrum economies are found in lush temperate and boreal environments (Winterhalder & Smith 1981; Binford 1980).

Of special interest here is the archaeological record of early hunter-gatherers in the wetlands and forested areas of South America. Large campsites of the early to middle Archaic periods containing direct or indirect evidence of a broad subsistence base and long-term use are often found in these temperate environments, as is the case also in mid-northern Europe (Butzer 1971). In much of the eastern and midwestern United States, wetlands were attractive "pull" zones that reduced early Archaic group mobility (Brown & Vierra 1983; Collins & Driskell 1979:1036; Lopinot 1982; Nance 1988; Rossen 1998a). Case studies in those regions emphasize the broad exploitation of various wetlands microniches such as shorelines, shallow water, and deep water zones. Although little research has been carried out in the temperate zones of South America, ecological and archaeological patterns of plant-oriented subsistence are emerging at more Late Pleistocene and early Holocene sites in Chile, Peru, and Brazil.

Although the remains of nuts, berries, stems, fruits, and other edible parts have been recovered from several early sites, most noteworthy here are below-ground plants or plant parts (*e.g.*, tubers, reeds and sedges; Hatley & Kappelman 1980; Coursey & Booth 1977; see Ramirez 1989 and Rossen & Ramirez 1997 for southern Chile) and their broader implications for economic viability. These parts are special because they usually are less affected by drought, fire, seasonal fluctuations, and grazing than above-ground plants, and they are exploited by fewer competing predators. They also store naturally for long periods of time that allow greater residential stability.

Summarized below are a few case studies discussing the general characteristics of the paleoenvironment and resource base of some of the best documented Late Pleistocene and early Archaic sites, the archeological evidence for a generalized subsistence economy, and the implications of these sites for studying later social and cultural developments. These cases are not intended to represent all early time periods and regional environments.

Monte Verde in South-Central Chile

The site of Monte Verde is located on a high terrace plain along the banks of a small tributary of the Maullin River in southern Chile (Figure 1). Today, the cool, temperate landscape of Monte Verde is characterized by varied surface features: rainforests of mixed coniferous and broadleaf trees, rolling hills and low and high mountain ranges,

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large fertile river plains and river valleys, expansive wetlands and grasslands, freshwater and saltwater marshes, lagoons and bogs, and coastal plains. Cool and wet conditions similar to the present-day rainforest environment prevailed in the region some 16,000 to 12,000 years ago (Dillehay 1984, 1986, 1989).

Two cultural components have been identified at Monte Verde. The youngest component is well-preserved by an overlying peat layer, and is radiocarbon dated around 12,500 yr B.P. The oldest component is equivocal, lies in a different area of the site, and possibly dates as far back as 33,000 yr B.P. (Dillehay & Collins 1988; Dillehay 1997). Only the cultural materials from the younger, better known 12,500 yr B.P. component are considered here.

Several characteristics of this component are important. Wooden foundations of a long tent-like structure were excavated. The architectural base of an isolated wishbone-shaped structure also was found in a specialized, nonresidential sector of the site. The tent-like and wishbone-shaped structures appear to be components of a planned settlement that was integrated both spatially and functionally.

A diversified stone tool industry was made up of three basic technologies: selectively collected, naturally fractured, and culturally utilized stones with one or more sharp, usable edges; unifacially and bifacially flaked tools; and pecked-ground bola and grinding stones. These three simultaneously utilized technologies indicate a diversified economy of plant gathering and hunting. Residue material appears on the working edges of many lithic tools. Comparison with microscopic cellular fragments of living plants indicates that seaweeds and aquatic plants were processed regularly. Several tools were also used for artisanal or architectural maintenance (hut construction). Other lithic specimens exhibit wood carbon on the edges indicating that charred wood was worked. These tools were recovered alongside burned and worked wood in all areas of the site. There are also several planing and gouging tools, grinding stones and wooden mortars that suggest a plant-based economy. In sum, there is plenty of nonplant evidence indicative of the exploitation and preparation of wetland and forest plant species.

The plant-oriented unifacial tool industry at Monte Verde is not unusual. Most synthesizers of early South American prehistory have recognized an early unifacial flake or edge-trimmed tool tradition which was probably associated with working wood, skin, plants, bone, fiber, shell, and feathers (Bryan 1978, 1986; Richardson 1978; Gruhn & Bryan 1998; Dillehay 2000). Although a wide variety of bifacial industries occur across the continent as well, the unifacial industries are most often associated with late glacial and post-glacial savanna-parkland and thorn forests in eastern Brazil, with savanna and forested plains in Colombia, mangrove swamps and arid savanna-woodlands in coastal Ecuador and possibly the Talara area on the north coast of Peru (Figure 1), and with

cool temperate rainforests in southern Chile. Irrespective of location, all early sites characterized by unifacial industries and by good preservation of organic faunal and floral remains are associated with a broad-spectrum foraging economy.

Hunting and/or scavenging game is suggested by the bone remains of at least seven individual mastodons, one paleocamelid and small animals. Meat probably contributed a significant proportion of the protein, but the supply may not have been regular and variation in amount of meat between individually hunted or scavenged animals would have been a factor. Hunting or scavenging for small- and medium-sized animals was probably not of nutritional significance but other categories of food sources might have been useful.

A well-preserved collection of plant remains (*i.e.*, seeds, pods, leaves, flowers, pollen, fruits, nuts, tubers, and stems) and wooden artifacts suggest much about the past economy, technology, and ecology. The wood assemblage confirms the long-held idea that plant and other organic materials played important technological roles in Late Pleistocene cultures (Kreiger 1964; Bryan 1978, 1986; Richardson 1978). These materials also provide detailed data for reconstructing the economic catchment zone of the site's inhabitants and the general configuration of the local ecology, which revealed that the Monte Verdeans were gathering resources up and down the river system from the highlands to the coast.

The macrobotanical remains include more than sixty plant species that sequentially mature during all seasons of the year in different ecological zones (Dillehay 1984, 1986; Ramirez 1989; Rossen & Ramirez 1997). Grains, seeds, nuts, tuber and rhizome skins, tubers, bulbs, roots, and soft leafy material recovered from food pits and hearths inside hut structures and from cracks and pits in wooden mortars have yielded information both on the species of above-ground and below-ground plants that were used by the Monte Verdeans and on the general nature of the diet.

Among the archaeologically recovered plants, a few species are staple plants that are available year-round, and have edible greens, seeds, rhizomes or tubers. These species include *Juncus procerus*, *Scirpus californicus*, *Carex* sp., *Gunnera* sp., and *Solanum maglia* (Rossen & Ramirez 1997:333–338). Numerous other recovered species represent seasonal foods, especially summer fruits, that supplemented the basic plant foods. Certain plants, including a white mushroom (*Clavaria coralloides*), a bamboo (*Chusquea* sp.), and four seaweeds (*Durvillaea antarctica*, *Gracilaria* sp., *Porphyra* sp., and *Sargassum* sp.; Figures 2 & 3) have specific seasonalities to suggest they were utilized during the non-summer months when overall plant food availability was lower. Ten species of halophytes, native to the coastal salt marshes or sand dunes 55 km west of Monte Verde, with high salt content suggest a focus on salt as a key resource (Rossen & Ramirez 1997:344). Based on their use today

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by Mapuche shamans, it is likely that ten recovered species had exclusive medicinal uses and, along with thirteen edible species with corollary medicinal uses, appear to represent a versatile pharmacopoeia related to the treatment of a wide variety of ailments (Rossen & Ramirez 1997:339–342). A noteworthy plant remain recovered in great frequency is the spores of club moss (*Lycopodium* sp.), which seem to have been used as a fire starter. From many perspectives, plant use at Monte Verde was varied and complex, involving an intimate knowledge of local and nonlocal microenvironments, distributions, seasonal availabilities, and botanical attributes.

Within the broad spectrum of plant use displayed archaeologically at Monte Verde, perhaps the most interesting of this group are tubers. One, *Solanum*, is grown by the present-day indigenous Mapuche and Huilliche groups. Moreover, there are at least three-hundred other species of wild potatoes available in the area today, most of which have several economic uses (cf. Bukasov 1930; Correl 1962; Vavilov 1951; Ugent *et al.* 1986; Ramirez, personal communication, 1983; personal observations). It is likely that some of these species were also exploited by the Monte Verdeans but were not recovered archaeologically.

Tubers and rhizomes would have provided a year-round food supply for the site's inhabitants. When the underground parts of these plants are left or stored in their natural underground habitat, they are foods with a long "use-life" (*sensu* Labuza 1962; Soffer 1989) and banking capacity. (The Mapuche and Huilliche extend the use-life of potatoes from 2–6 years by leaving them in the ground or storing them in deep pits in wet terrain [Alejandro Herrera, personal communication, 1989; personal observation]. If collected and stored culturally, these parts rot in less than five months.)

These plants could have provided a majority of the Monte Verdean's daily intake of protein, carbohydrates, starch, minerals, and other elements, particularly during the winter months when bog fruits were unavailable. To give an example of the nutritional value of protein, *Solanum maglia* tubers yield about 5.2 gm per 100 gm, *Juncus procerns* seeds render 7.3 gm per 100 gm, and *Scirpus californicus* roots give 7.2 gm per 100 gm (Laboratorio Fitoquímica, 1983). Figures for the other elements are also moderately high.

Tubers and rhizomes are relatively easy to procure. The indigenous Huilliche living in the area today use digging sticks made of tree branches or cow ribs to collect them. Both modified wooden sticks and mastodon ribs, characterized by blunted and/or burned edges, have been recovered from Monte Verde (Dillehay 1997). Micro-use wear studies of these and replicative digging sticks, suggest that the site's inhabitants were probably using these implements to extract underground food parts.

Based on the reconstruction of past and present resource structures in the study area, we can infer that the Monte Verdeans chose two complementary ways to procure tubers,



FIGURE 2. A masticated cud recovered from the floor of the wishbone-shaped structure dated to *ca.* 12,500 yr B.P. The cud is comprised of fragments of boldo leaves and of three different types of seaweed, all of which are medicinal elements. The cud is presumed to have been chewed by the site's inhabitants and tossed on the floor.

rhizomes, and other foods. One way was to exploit the patchiness of a primary set of resource zones in the Maullin River drainage. The archaeological presence of a wide range of inorganic and organic resources from multiple environmental zones in the river basin suggests a linear catchment zone (see Dillehay 1989; Ramirez 1989; Rossen & Dillehay 1997), stretching from the littoral in the west to the Andean grasslands to the east. Several materials, including discoidal abraded stones, salt, clay, quartzite and other stones, four varieties of seaweed, petrified plant stalks from the coast and plants such as the aforementioned club moss from the highlands attest to the exploitation of resources from distant poles of the river basin (Dillehay 1984, 1986, 1989; Dillehay & Rossen 1997; Rossen & Dillehay 1997). This pattern suggests that the site inhabitants regulated the dispersion, supply, and preservative properties of selected seasonally available plant species. The other possible procurement technique was to target certain wetland habitats where an abundant year-round supply of below-ground tubers and rhizomes were concentrated. The most productive and accessible wetlands were on the upland terraces where numerous bogs, swamps, and lagoons were located. Furthermore, seasonal fluctuation of the water table periodically reduces access to certain wetlands zones, allowing economic

plant populations to rejuvenate and reducing the potential for resource depletion. If the Monte Verdeans targeted such areas for exploitation, it might have been to their advantage to settle in for a year or so to take advantage of the abundance and the diversity of wetland resources.

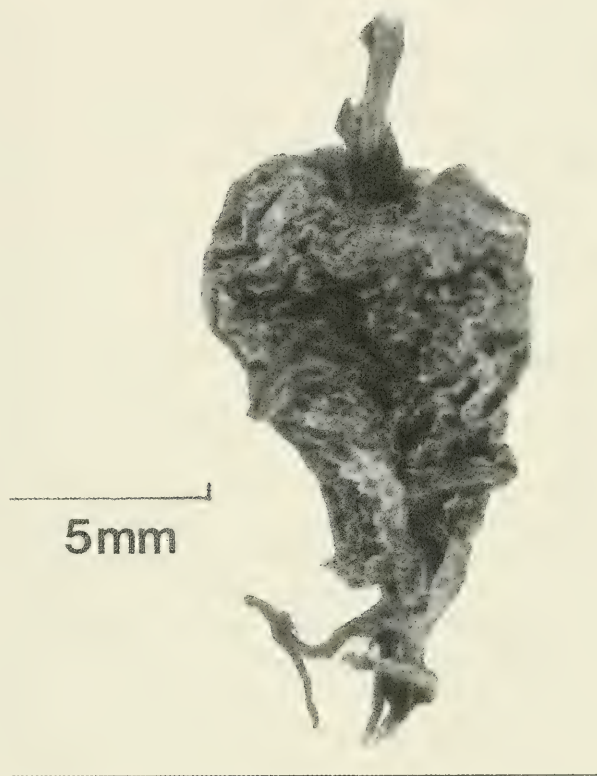


FIGURE 3. A desiccated bulb of a wild potato (*Solanum maglia*) recovered from the floor of the long tentlike structure dated at 12,500 yr B.P. at Monte Verde.

Las Vegas in Coastal Ecuador

Another diversified economy is demonstrated at the Las Vegas site in southwest coastal Ecuador (Stothert 1998). Although people may have lived at the site around 10,000 years ago, a later component dated between 9,700 and 7,000 yr B.P. is associated with phytoliths of domesticated squash, gourds, maize and edible roots. The early Las

Vegas people also exploited deer, small animals, peccary, reptiles, and birds in adjacent tropical forests and mangrove swamps, as well as fish and shellfish from the sea.

The simple stone tool industry demonstrates increasing skill in tool kits, and the greater significance of plant-collecting implements, including small mortar stones. People who viewed almost all living organisms as potential sources of food and were willing to organize their activities to collect them, would have been developing an awareness and organizational system potentially receptive to the collection and eventual domestication of wild plant foods. Heavier ground stone tools first appear in sites. These may have been used to grind minerals, but their uses became familiar with the characteristics and potential of ground stone implements that later could be adapted to grinding plant food.

Nanchoc Culture in Northern Peru

Early Holocene sites throughout northern Peru are known for their diversified economies. In particular, coastal sites throughout Peru exhibit an emphasis on various maritime and shoreline resources, and incidental recovery of wild and perhaps cultivated plants (Richardson 1978). Inland coastal valley sites from this time have been less studied, but a series of sites from the upper Zana Valley dating from 8,500 to 6,000 yr B.P. exhibit a plant-oriented economy that may include a precocious suite of semi-domesticates or cultigens from various altitudes and environments (Rossen *et al.* 1996). These plants include squash, peanuts, quinoa, and Solanaceous and cactus fruits. It appears that plants were introduced to middle and upper valley ecotones from highland and tropical forest settings, and that plant experimentation was an economic foundation and an impetus of culture change. These sites are among very few in Peru where systematic water flotation has been conducted, and direct A.M.S. dates have been inconsistent. There can be little doubt, however, on the basis of varied, well-made, exclusively unifacial chipped lithic and ground stone industries, that early Holocene economies in the region were heavily plant-oriented (Dillehay *et al.* 1997; Rossen 1998b). Faunal assemblages are dominated by mollusks and small game.

Several Sites in Central Brazil

Almost thirty Late Pleistocene and early Holocene sites ranging in radiocarbon dates from 12,300 to 8,000 years ago have been reported from central Brazil (Schmitz 1987; Prous 1996; Kipnis 1998). These sites display diverse economies based on seeds and palm nuts (sometimes filling entire pit features and midden lenses), along with wild fruits. Perishable wooden and reed artifacts are present in at least three sites (Kipnis 1998:587).

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The importance of wild plant collecting continues even much later, when maize and manioc cultivation was locally introduced. Faunal remains too are diverse, emphasizing small game and birds. Even without the use of specialized plant recovery techniques by archaeologists, scholars specifically draw a dichotomy between Late Pleistocene plant gathering cultures of central Brazil and the “big-game hunting model” that remains pre-eminent in North America (Kipnis 1998:590).

In sum, we suspect that for a few early societies, subsistence pursuits may occasionally have been concentrated on large animal species as the primary source of meat; for the sites discussed above and surely for most early societies, the variety of foods consumed was broadened to include small animals, snails, waterfowl, fish, mussels, and plants. Certain societies, such as the Las Vegas and perhaps the Nanchoc communities, which existed at the end of the Pleistocene, possessed traits preadapted to horticulture. Those that relied on hunting and gathering for subsistence began to experiment with the plants and animals being used as resources. It is likely that the early inhabitants of many areas also collected plant material, but their remains have not been found primarily because most sites have not been subjected to detailed plant recovery techniques.

Foraging, Food Storage, Collecting, and Residential Stability

Several investigators have noted that the absence of storage facilities in hunter-gatherer sites may suggest that site inhabitants were foragers. A central feature of a foraging society is that economic activities relate primarily to the immediate needs of the group, and not to the anticipated needs of the future. Thus, long-term storage is not considered to be a primary aspect of foraging organization (Binford 1978, 1980). It is, however, collectors who engage in logistical activities in which a task group collects resources and brings them back to a base camp. In this case, storage is vital for stockpiling surplus over the next several months (Flannery 1969; Binford 1978, 1987; Redman 1977). Exceptions to these generalizations and to storage facilities can be foraging hunter-gatherer groups in lower latitudes zones. Low latitude zones often contain a high density of foods that permit foragers to gather resources each day on an “encounter” basis (Binford 1980).

Our model of hunting and gathering at Monte Verde, for example, includes both “encounter” foraging and “logistical” collecting, depending on the season, environmental zone, and combination of resources present (Rossen & Dillehay 1997). In this area, a compact mosaic of economic plant microzones produced an unusually varied economic plant inventory, along with prolonged seasonal plant availabilities as individual plant species matured differentially in different plant microzones (Rossen & Ramirez 1997). The logistical collection of dense, patchy resources like tubers and rhizomes, however,

probably produced the staple foundation of the diet. Yet, there are no identifiable storage facilities at Monte Verde. The Monte Verdeans were probably sedentary nonstorers who relied on the underground storage and nutritional banking of certain tubers and rhizomes with long use-lives and on the occasional exploitation of big-game animals to remain in one location for a long period of the year. By relying on a primary set of plant and animal food resources on a daily encounter basis in nearby bogs and marshes, the Monte Verdeans did not necessarily need to actively store food for the lean months. Supplemental food resources, such as nuts, soft leafy plants, mushrooms, seaweeds, fruits, and small game could have been gathered in these same environments.

There are other significant implications of naturally stored foods. Natural storage would not have necessitated changes in the labor, mobility, technology, and social structure of the resident population, changes that might have led to the construction and maintenance of storage features in the site. And it would not have forced the Monte Verdeans to have mobilized labor during limited seasonal periods. It also would have anchored the Monte Verdeans to a particular location, probably limiting their resource mobility, and, in some cases, leading to periodic longer stays at the site, depending on circumstances from year to year.

Those who laid the foundation for the human presence at Monte Verde remain unknown. The cause and nature of these developments are difficult to discern, because we know nothing about what preceded or succeeded it. We can assume that a transition occurred from nomadic foragers to a mixed strategy of plant collecting, foraging, scavenging, and hunting. We cannot assume, however, that in the rich temperate wetlands of south-central Chile animal meat was the preferred food, that a shortage of animal protein was a limiting factor on the size, distribution, and permanence of the site, or that any intense exploitation of plant food was a shift to less desirable foods. In following Cohen's (1977) now familiar argument, this shift would be expected if the human population had expanded to the point where it could no longer be sufficiently supported by available game. Although the settlement pattern data are lacking, it is highly unlikely, in our opinion, that such pressure existed in Late Pleistocene times. It is our guess that, in the case of Monte Verde, the generalized economy and settlement stability was primarily founded on the high diversity and density and year-round availability of seeds, nuts, fruits, and the nutrient-rich, below-ground, plant foods and their large patchy distribution in space. These resources, coupled with animal meat, would have provided a high quality of minerals and carbohydrates, starch, trace elements, and plant and animal protein.

Conclusions

Undoubtedly, new discoveries and directions in the interpretation of initial human settlement in unexplored wetland and wooded environments will clarify our understanding of the role of early technologies and different plant foods in subsistence economies. Future research will undoubtedly lead to new inquiries about the cultural transition between Late Pleistocene and early Archaic populations in the Americas. To date, the Late Pleistocene prehistory of one region — the cool, temperate rainforest of southern Chile — is basically the story of one archaeological site, Monte Verde. The inhabitants of Monte Verde had a generalized economy, characterized by a primary set of staple plant (seeds, fruits, tubers and rhizomes) and animal (mastodon and paleollama) resources. These people generally had a low level of stone tool technological development, but apparently a high level of organization to meet their economic and other needs. Their exploitation patterns included both encounter foraging and logistical collecting of plants and animals, yet it appears that logistical collecting of staple plants with long availabilities was central to their local permanence. Similar patterns are also being recorded at sites in eastern Brazil, northern Peru, and southern Ecuador. Future study surely will find them in many other forested and wetland environments and document further the presence of early broad-spectrum economies.

Finally, to more fully understand the first peopling of the Americas, we must develop research questions and strategies to study early adaptive processes on a comparative local and hemispherical basis that can lead to significant insights into the plasticity of Late Pleistocene cultures. With more research we may see that early cultures were far from being uniform and static, and were individually, subculturally, and temporally variable. We also need to search for new models, construct new scenarios that better reflect what we know about ethnographic hunter-gatherers, and develop new methodological strategies of excavation and analysis that include water flotation and other techniques designed to recover minute plant remains. The archaeological record may be fragmentary, but it is more so if we do not bother to collect what is there.

Abstract

Due to preservation and paradigm bias, plant collecting is generally given little attention in modeling the adaptation of early foragers in the Americas. We discuss the social and economic implications of early archeological records where plant preservation is good, such as Monte Verde in Chile and several sites in Brazil, and their meaning with respect to the exploitation of wetland environ-

ments and the peopling of the New World. We demonstrate that reliance on a large number and type of plant resources typified the earliest human economies of South America.

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CHAPTER NINE

OCEAN TRAILS AND PRAIRIE PATHS? THOUGHTS ABOUT CLOVIS ORIGINS

Dennis Stanford and Bruce Bradley



Archaeologists have long believed that artifacts unearthed with mammoth bones in a gravel pit near Clovis, New Mexico were made by the First Americans (see Bonnicksen & Turnmire 1991). The people who made these tools, known as Clovis, were hunters and gatherers adapted to the diverse and changing environments of North America during the transition between the Pleistocene and the Holocene. Archaeological sites containing Clovis artifacts are found from coast to coast and from Canada to Central America. These sites are identified on the basis of distinctive bifacial, fluted projectile points and blade core technology.

However, the origin of Clovis culture and technology remains a mystery. Traditionally, most archaeologists have reasoned that the ancestors of Clovis people came from Asia by crossing a land bridge connecting Siberia and Alaska. This land bridge formed when Ice Age sea levels were depressed while water was trapped as glacial ice. It is thought that after early populations arrived in Alaska, terrestrial glaciers began to melt creating an inland route, or “Ice-free Corridor,” that joined the Arctic with the rest of the Americas. Clovis people presumably spread southward through the continent by means of this pedestrian route. This land bridge/interior-corridor hypothesis seems eminently logical as Siberia lies in geographic proximity to Alaska, and pedestrian routes until recently have been favored strongly over maritime routes in North American colonization models. Further, many modern North American Indians share physical similarities with current Northeast Asians. Consequently, little doubt existed in the minds of many scholars that the bearers of Clovis culture were ancestral to most modern Native Americans. For proponents of this hypothesis, Siberia and Alaska are logical places to search for the roots of Clovis culture.

Evidence for Asian Origins

Scholars have sought to find archeological evidence of Clovis origins for decades. One of the earliest studies aimed directly at finding evidence of early Clovis peoples in the ice-free corridor was that of H. M. Wormington and Richard Forbis (1965). In the 1950s they surveyed collections and sites in Alberta just below the exit point of the corridor. Their efforts failed to locate archaeological material suggestive of early or pre-Clovis; indeed, the few Clovis specimens they recorded occurred much further south in the Province. Canadian archaeologists still have not found archaeological evidence to confirm a human presence in the corridor before 11,000 years ago (Beaudoin *et al.* 1996). A few fluted projectile points have been found in the corridor (see Carlson 1991), but these undated artifacts appear to be related to the fluted points found in Alaska, which are thought to date around 10,500 yr B.P. (Hamilton & Goebel 1999).

Evidence of an early Clovis lithic technology in Alaska has also eluded researchers. Only the Nenana Complex, found in Central Alaska (Powers & Hoffecker 1990), is thought by some investigators to be related to Clovis (Goebel *et al.* 1991). The breakage pattern on the small thin bifaces found at Nenana sites suggest to us that these tools were likely used as knives. Although there are some other technological correspondences between Clovis and Nenana, the evidence for the comparison is weak. While there are some early dates for Nenana, most of the radiocarbon evidence suggests that it is virtually contemporaneous with Clovis. Thus, it appears to us that there is little archeological evidence that Clovis ancestors crossed the land bridge or passed down an ice-free corridor linking Northeast Asia to America.

Recent research indicates that the ice-free corridor may not have opened up until 11,000 yr B.P. (Jackson *et al.* 1996). After deglaciation, the ice-free corridor may have been barren of plant and animal life for a long period of time, and this would have rendered the area unsuitable for human habitation (Burns 1996; Mandryk 1990), until after Clovis times. If this was the case, an interior land route to the Americas was essentially blocked for early explorers between 22,000 and 11,000 years ago.

Evidence for Ocean Trails

Given the relatively late timing of viable human travel in the ice-free corridor and the early dates at Monte Verde and other archaeological sites in the Americas, it appears that early explorers must have used alternative paths to the New World. Some scholars (Fladmark 1979; Dixon 1999) believe that it is likely that people using watercraft established a foothold in the Americas while exploiting the coastal environments of the

Pacific continental shelf, which apparently was ice-free by 13,000 years ago (Josenhans *et al.* 1997). Recent efforts to reconstruct former environments and ecosystems verify that Pleistocene animals flourished along the Ice Age coastline (Heaton 1996). Further, cultural artifacts have been found along these coastal environments (Erlandson *et al.* 1998; Dixon 1999), as well as from off shore drowned terrestrial and intertidal deposits (Fedje & Josenhans 2000). Thus far, the coastal discoveries are too young and they do not appear to be technologically related to Clovis. These discoveries indicate, however, that humans were indeed utilizing the now-inundated continental shelf, and future research may find evidence of earlier occupations.

Indirect evidence indicates that watercraft were in use on the Pacific Ocean early in the known prehistory of the dispersion of modern humans. For example, nearly 50,000 years ago, the ancestors of the Australian Aborigines crossed a deep ocean trench, the Timor Trough, while traveling from Southeast Asia to the ancestral Australian-New Guinea continent of Sahul, a distance of 80 kilometers (Mulvaney & Kamminga 1999). Over 30,000 years ago Paleolithic flintknappers from Japan traveled by watercraft to collect obsidian from Kazushima Island, now located some 170 km off shore (Oda 1990). It is our opinion that the idea of such an inherently useful technology as watercraft probably spread rapidly among populations around the world. Indeed, obsidian from the Island of Melos found in the Late Paleolithic levels of Franchthi Cave in Greece (Perles 1987), suggest seafaring capabilities by that time (van Andel & Shackleton 1982). Considering that simple raft and boat technologies underwent “research and development” for nearly 40,000 years prior to Clovis times, it seems reasonable to presume that some groups ably navigated the waters of the North Pacific Rim and quite likely those of the North Atlantic by Late Pleistocene times.

Identifying archaeological evidence supporting the former existence of ancient water transport is problematic (Bednarik 1997). Materials used in early watercraft construction were perishable and would not readily survive in most environments. Further, such craft are usually stored near water and would have suffered degradation through erosion by the tides of rapidly rising sea levels associated with deglaciation. This situation may also hold true for many coastal habitation sites as well. Thus, finding evidence of the former use of Paleolithic watercraft or the occupation of early sites on the continental shelf requires strategic concerted effort and no small element of luck.

Evidence for Clovis Ties to Asia?

A growing number of researchers, including the present authors, have examined many of the Late Pleistocene archaeological sites and museum collections in Eurasia,

Asia and the Far East in order to seek ties with Clovis. But, to date, no clear-cut evidence is discernible. Asian Upper Paleolithic technologies are dominated by microblades made from wedge-shaped cores (Derev'anko 1998). When used in weaponry, multiple microblade segments were inset into long, narrow, pointed rods of bone, antler or ivory to form long, lethal, cutting edges. In contrast, Clovis stone weapon tips consisted of thin, flat bifaces with concave bases that attached directly to the end of a shaft or foreshaft. Conceptually, these are entirely different approaches to making effective weapons.

The incidence of bifaces in Northeast Asia is significantly lower than that documented for Clovis. Moreover, when bifacial technology was used in Northeast Asia, the resultant artifacts tended to be thick in relationship to their width and they were usually bipointed. Clovis technology on the other hand included two basic approaches to stone tool manufacture: biface production, and blades and bladelets made from nonwedged shaped cores. These two reduction techniques are infrequently associated with one another in Northeast Asia. In the Trans-Baikal region of central Asia, some assemblages include bifaces and large blade cores as part of the flintknappers' repertoire (Kirillov & Derevanko 1998). Such sites are rare, are older than Clovis by more than twenty millennia, and are separated from Alaska by some 5,000 km, across some of the coldest and most inhospitable areas of the world. Further, they appear to be more closely related to the Streletskayan technology of the Eurasian Plain than to those of the Far East (Bradley *et al.* 1995).

Since known Asian technologies do not appear to satisfy expectations of a Clovis technological prototype, if Clovis peoples came out of Northeast Asia, then their distinctive technology evidently developed after they colonized the New World. If this were the case there should be identifiable links indicating a transition in the manufacture of projectile points from the use of inset microblades to hafted bifaces. Or, our preconceived notion about where Clovis people originated may be incorrect.

Alternative Paths for Clovis Origins

Although a number of authors (Cotter 1935; Greenman 1963; Boldurian & Cotter 1999) have pointed out similarities between the American Paleoindian technologies and the Paleolithic of Europe, it was Jelinek (1971) who identified the Solutrean culture in the Vasco-Cantrabrian region of Northern Spain, as having the most striking resemblance to the Clovis technology. He noted that the similarity included bifacially flaked lanceolate, projectile points with concave bases and basal and edge grinding, a basic blade industry, small end scrapers with graver tips, large side scrapers made on flakes, cylindrical bevel-based bone points, and a relative scarcity of burins. However, he felt that a

direct historical relationship between Clovis and Solutrean was impossible because: 1) Solutrean is more than 5,000 years older than Clovis; and 2) of the difficulty of crossing the late glacial Atlantic Ocean (Jelinek 1971:15–21). In a recent article, Straus (2000a), also enumerates these same reservations. Thus, the time and space gaps suggest that the similarities of these cultures resulted from independent invention. And, unless these issues are resolved, the comparison of Clovis and Solutrean will only provide useful data on why such a cultural convergence might occur. However, we suggest that perhaps these gaps may even now be resolved and certainly if scholars do not look beyond their current biases, new evidence will not be forthcoming.

Filling the Time Gap

Meadowcroft rock shelter in Pennsylvania includes a stratified deposit that contains human occupation levels dating to perhaps a thousand years before Clovis (Carlisle & Adovasio 1982). The artifacts found in the older deposits suggest a technology that included bladelets and unfluted bifacial projectile points and basketry (Adovasio *et al.* 1978). The site has long been a thorn in the side of scholars who advocate that Clovis peoples were the first Americans. Their arguments contend that the radiocarbon samples were contaminated by coal residue in groundwater percolating through the cave deposits or other phenomena mixing prehuman deposits with cultural charcoal (Haynes 1980). Recent microstratigraphic research concludes that there was not a contamination problem with the dates (Goldberg *et al.* 1999). It should be pointed out that none of the putative pre-Clovis charcoal dates from the Alaskan sites have undergone similar intense scrutiny as the Meadowcroft dates even though the contamination and soil mixing are major problems in the Arctic. Could this inequity reflect the preconceived notions of scholars wishing to find the Alaskan link to Clovis? Nonetheless, Meadowcroft stood out as a single anomaly and the existence of such an early occupation would be inconclusive until other sites, dating to the same time period and containing similar artifacts, were found and documented.

Along the Nottoway River in Virginia a site known as Cactus Hill has recently produced a classic sequence of Mid-Atlantic archaeology, including Clovis and occupations below Clovis (McAvoy & McAvoy 1997). The artifacts from the lower levels, thin bifacial points, large blades, bladelets, cores, and other tools, are technologically similar to those from the Meadowcroft and could be considered a related complex. The radiocarbon dates from a hearth feature and other samples suggest that the site was occupied between 15,000 and 17,000 14 C yr B.P. Although the combined artifact samples from both sites are small, we suggest that these two assemblages should be considered part of

the same technological complex. Further, their chronological placement suggests to us that they are prime candidates for developmental Clovis.

It is important to note that there are significantly more fluted points and sites found in the eastern United States than in the rest of North America (Mason 1962; Anderson & Gillam 1999), as well as the greatest variation in fluted point forms and technology (Lepper 1999). Although certainly not conclusive, these circumstances indicate to us that the Clovis Tradition may have a greater time depth in the east and that Clovis probably developed its characteristic technological aspects in the east. If this is true, along with the pre-Clovis dates from Meadowcroft and Cactus Hill, there is a high degree of probability that the lithic technology from these sites represents a likely precursor of Clovis technology.

We are also struck with the number of technological similarities shared among Meadowcroft, Cactus Hill, Clovis and Solutrean flaked stone artifacts. For example, the Meadowcroft/Cactus Hill bifacial weapon tips are technologically very similar to some Solutrean points and though they lack the fluting found on Clovis specimens, they are basely thinned. Similar too are the blades and smaller blade cores. Further, some of the radiocarbon dates for these sites overlap in time with Solutrean. If these dates prove to be accurate, we see the possibility of a developmental continuum from Solutrean through Cactus Hill and Meadowcroft to Clovis, filling in the 5,000-year time gap.

Coincidentally with the discovery at Cactus Hill, the results of DNA research on ancient human remains have begun to map genetic relationships among the world's populations. From this research it is clear that modern Native Americans have an overwhelming genetic contribution from Asian ancestors. However, mixed into the genetic composition of a few Indian groups is a mitochondrial DNA haplogroup known as X (Schurr 2000). This haplogroup is absent in eastern Asia but occurs in Europe. The haplogroup X marker has been found in several pre-Columbian populations, suggesting to Schurr (2000) the possibility that the haplogroup was present in the New World over 12,000–34,000 years ago. Could the population that carried this genetic marker from Europe to the Americas have been Solutrean people?

The Solutrean Evidence

With these new data and the questions they pose, we felt that the hypothesis of a Solutrean origin for some of the first American human populations needed to be seriously examined. Thus, we arranged to look at collections in various museums in Spain, France and Portugal. We also studied site reports and syntheses of the Solutrean archaeological data.

OCEAN TRAILS AND PRAIRIE PATHS

Our examination of these materials was most illuminating. The degree of similarity we found was greater than anticipated. In collection after collection, we viewed artifacts that we would not have been surprised to find at a Clovis site. One of the most remarkable technological features of stone working was the identical technique that both groups used to manufacture thin bifaces. This is a technique that archaeologists call overshot flaking (Frison & Bradley 1999), that is, striking a flake that starts on one edge of the biface and travels across the entire surface and removes a small portion of the opposite edge. This technique rapidly thins a biface with relatively few flakes. In our examination of biface thinning around the world, only these two groups consistently and purposefully used the overshot technique. This is not to say that overshot flakes never occurred in other technologies. But in these cases, careful examination of assemblages does show them to be only occasionally present, and in most cases it is clear that they were knapping mistakes.

There are also technological similarities between Clovis and Solutrean blade manufacture. The methods of precore shaping, setting up the core face, and blade detachment techniques are virtually identical between the two groups. In fact, we see Solutrean blade technology as closer to Clovis than it is to any other European blade core technologies used either before or after Solutrean.

Other traits related to flaked stone that are shared between Clovis and Solutrean, but are not present in other Paleolithic technologies, include the preference for exotic raw materials in the manufacture of bifaces (*e.g.*, Balout 1958:619), pressure flaking and occasional heat-treating of flint. Caches of over-sized bifaces (Smith 1966), that can be argued were not intended to be used, are another trait shared between Clovis and Solutrean. These traits are rare to absent in the Far East Upper Paleolithic traditions.

The similarities in tools went beyond the stone technology. Many Solutrean bone, antler and ivory tools have close Clovis analogues, this is especially true for bone projectile points or bone rods (Smith 1966). The manufacturing and even decoration in some instances were nearly identical. Bone shaft wrenches are found in both assemblages, and, although eyed bone needles and bones disks with "tally marks" have not yet been found associated with Clovis, they do occur in the related Folsom culture. Along with incised decoration on bone points, engraved stones, etched with geometric and zoomorphic designs have been found in both cultures (Smith 1966; Collins *et al.* 1991). After our study of the Solutrean collections, we were deeply impressed with the amount of concurrence we observed. Among the questions that we pondered was how much similarity is necessary before an interpretation of convergence gives way to an historical relationship? It was clear to us that if the Solutrean artifacts we observed were found in Northeastern Asia, no one would doubt the connection to Clovis.

Filling the Space Gap

If there was an historic connection, the remaining questions to be addressed are issues of the crossing of the Atlantic Ocean. Did the Solutreans possess the necessary skills, have the right equipment, and why would they undertake such a journey? These questions have seldom been seriously considered because of the preconceived biases of scholars working in both areas of the world. Scholars presume that these people were of such a rude state of technological knowledge that such endeavors would have been impossible for them to accomplish. Further, it is commonly thought that during the Last Glacial Maximum (LGM) — the time of the Solutrean people — the environment was too cold, harsh and stormy for Paleolithic people to venture out onto the Atlantic Ocean (Straus 2000a). If they did, there must have been some extreme reason for such deeds.

Paleoclimatic reconstructions for Western Europe and the North Atlantic do indeed suggest that during the LGM, the weather was on average colder and stormier than at present. Even though the net climatic conditions over this period may have been harsh, there were intervals when this was not the case and there were climatic regimes alternating between dry and cold to temperate and humid (Butzer 1986; Rigaud & Simek 1990; Straus 1990).

It is thought that during Solutrean times, the terrestrial climatic conditions resulted in lowered temperatures, shortened growing seasons and a reduction in the extent and quality of natural grasslands (Straus 1977). Game animals may have died out or become rare in the interior regions of Western Europe, and forced both animal and human populations into more favorable areas along the rivers and the coastlines of southwestern Europe (Straus 1977). Hunting was still possible in the nearby mountains, but more and more people likely turned to alternative food resources such as hunting and fishing along the river estuaries and beaches (Straus 2000b).

Sea ice would have been a common sight in the Bay of Biscay during Solutrean times (Webb *et al.* 1993). The summer seawater temperatures are thought to have dropped to 6°C (Rigaud & Simek 1990), which is within the temperature range for Arctic cod (0°C – 11°C [A. C. Jensen 1972]). The Arctic cod is a pivotal species in the arctic food web, and is an important prey item for sea mammals (Tynan & DeMaster 1997). It therefore seems likely that the Southwestern Europe pleniglacial seacoast would have provided an extremely rich habitat, attracting fish, birds and sea mammals. Since the Solutrean people resided on the coastal areas of Southwest Europe for more than two thousand years, we believe that it would not take them long to learn how to target these resources, especially if terrestrial resources were stressed.

Faunal collections from Solutrean sites in northern Spanish sites contain abundant evidence that these people were indeed utilizing coastal and estuary resources (Straus 1992,112) and there is evidence that through time there was an increasing dependence on marine resources (Straus 1985:505). For example, humans were transporting substantial amounts of limpets up to 10 km from the pleniglacial shore to La Reira Cave in Spain (Straus & Clark 1986). This led Straus (1992) to suggest that if many pleniglacial coastal sites were inundated, marine resources may have been even more significant as dietary supplements than the present evidence would indicate (Straus 1992:112). In reviewing the inland evidence, Cleyet-Merle and Madelaine (1995) suggest a very active marine exploitation by Paleolithic peoples and that the use of these resources has been underestimated by scholars.

If, as Straus intimates (1979), Solutrean camps were established on the pleniglacial beaches and estuaries of northern Spain, the geographical area in which they could expand their hunting territory would increase dramatically along that beach and as far northward as the south coast of Ice Age Ireland. The exploitation of this area may have originally started as seasonal trips, but through time, they could have established more semi-permanent campsites along the coastline. In fact, because of potential marine resources, the ancient coast and associated plain may have furnished an independent resources base beyond that available in the mountains. Further, these resources may have supported a larger Solutrean population than represented by the temporary hunting camps known from sites found near the present day coast of Spain.

Maritime Technology

In the process of adapting to coastal marine resources, people would have no doubt modified old tool kits and created new technologies to more efficiently exploit the sea. This may have been especially true for Solutrean people, as they have been characterized as developers of specialized technologies (Straus 1990). Among the necessary equipment to exploit the marine resources were waterproof clothing, nets, harpoon gear and watercraft. Once this equipment was developed, it could have opened up a whole new world for the Solutrean people to exploit.

Adovasio *et al.* (1996) have found that plant-fiber technology such as cordage, basketry, netting, and textiles were being produced in central Europe by 25,000 years ago. Thus, it is reasonable to assume that these technologies were known to and used by Solutrean peoples, allowing them a wider technology than that represented by their stone tools. Waterproof clothing could be made from either textiles or animal gut tissue, but would have in any case been necessary for survival in the LGM, so we assume that these items were already part of their personal gear.

With the knowledge of cordage manufacture, only simple modifications to land-based weaponry would be required for harpoon equipment and nets. Sharp durable end blades (points) are frequently part of harpoon technology in many parts of the world. We believe that it is highly probable that the thin concave base points found most commonly in Solutrean sites in north coastal Spanish assemblages may have been well suited for harpoon end blades.

As mentioned above, watercraft had been in use for at least 30,000 years before Solutrean times, so we feel that it is not too far-fetched that the news had traveled to the inhabitants of Western Europe. And cordage for ropes and fiber textiles for sails are also within reason. Even with the lack of physical evidence we see no reason to believe that these people did not have some type of watercraft. Just as there is no direct evidence that the ancestors of the Australian Aborigines or the Paleolithic peoples from Franchthi Cave had watercraft.

We think that a skin boat outfitted with sails, similar to the Inuit umiak or the Irish currachs are excellent models for Solutrean boats. Skin boats make an excellent vehicle for northern waters. They are light and durable, if properly treated, they are sea worthy for months. For instance the Brendan, a curragh made of ox hide by Severin (1978) was used to cross the Atlantic Ocean. The Brendan was coated with sheep tallow, which allowed the boat to be on the ocean for several months, without becoming waterlogged. Similar hides and fats were available byproducts of animals that Solutrean peoples were hunting in the coastal mountains of Spain.

The Route

Paleoceanographic studies of the North Atlantic suggest that during the LGM, a permanent arch of sea ice connected the Southwest coast of Ireland to the Grand Banks, forming a north Atlantic ice rim (Figure 1). Winter sea ice would have formed each year, extending the ice further south to between 45° and 50° north latitude depending on annual weather conditions (see Webb III *et al.* 1993). The Gulf Current that now extends across the North Atlantic shifted southwards, making a clockwise circulation pattern moving toward the coast of Portugal and returned westward from North Africa. The Gulf Current warmed a weak counter clockwise current that circulated in the North Atlantic (Robinson *et al.* 1995). This northern current would have moved northwestward from the Irish coast toward the Grand Banks and returned to the Bay of Biscay.

Even though the LGM North Atlantic has been characterized as cold and stormy, these hostile weather conditions were not continuous, being interrupted by periods of short term and perhaps even longer term intervals in which sailing conditions on open

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water would have been possible even for less experienced navigators. Regardless of weather conditions, it would not take too many generations of coastal dwellers to understand the signs of impending storms and the timing of these events. Nor would it have taken an observant hunter long to discover that floating ice islands and ice leads provided excellent havens during storms. These ice features reduced wave formation and provide pullout locations for setting up camps during inclement weather. An overturned, well-secured skin boat makes an excellent temporary shelter during such events. Further, sea mammals provide fuel oil for heating and cooking, and if necessary to assist in drying out skin boats.

We propose that in the two thousand or so years that Solutrean folks lived next to and observed these environmental parameters, they no doubt adapted to and capitalized on these resources. Further, as they became more skilled in seamanship, they would have ventured further and further out along the ice margin. Perhaps first as simple extended hunting trips and finally to spend entire summers hunting along the ice front. Eventually someone made it the mere 2500 km between the LGM coastlines of the Grand Banks and Ireland. When arriving in the area of the Grand Banks they found a fishery that would have been unimaginable to a New England fisherman. This would have been big news back in old country. Soon we suspect that more and more expeditions were undertaken, spreading the X haplotype into the Americas. Once established in North America, they spread southward along the now submerged continental shelf to eventually find new terrestrial hunting opportunities and perhaps new people with which to intermingle.

We feel that the diverse amount of similarities noted between Solutrean and Clovis suggests a more complex situation than simple convergence. It appears possible that the dating and technology represented by Cactus Hill and Meadowcroft sites provide the link between Solutrean and Clovis. It may be bold of us, in the face of a dearth of proof to coin the term “Atlantic Paleomaritime” for these hypothesized ice-edge-adapted people, however, we do so to spur future research on these issues and broaden the thinking of new generations of archaeologists. Much research needs to be conducted to either support or reject these ideas, but regardless of the outcome of future debates over these issues, we feel that it is time to start thinking outside the confines of our present paradigms.

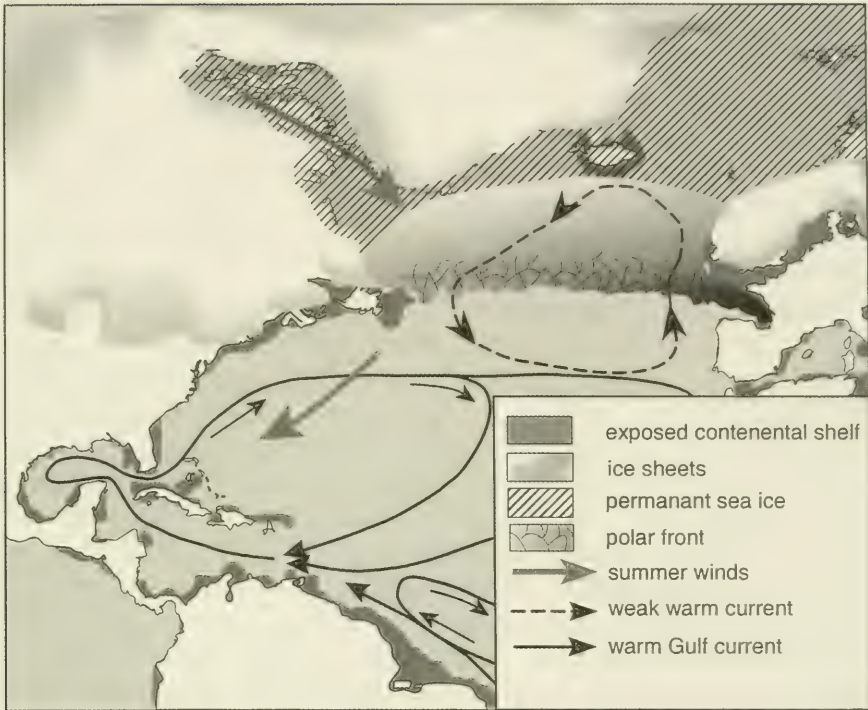


FIGURE 1. North Atlantic surface circulation reconstruction for the LGM. Adapted from Robinson *et al.* 1995; Webb *et al.* 1993.

Abstract

This paper discusses some of the current assumptions widely held about New World origins and outlines the reasoning that led the authors to explore an alternative hypothesis that Clovis technology may have had roots in the Solutrean Culture of the European Paleolithic. We suggest that Solutrean people began to adapt to marine resources in response to the harsh terrestrial environment of Western Europe during the Last Glacial Maximum (LGM). A maritime component of their adaptive orientation, termed here North Atlantic Paleomarine, enabled the movement of people westward along the margins of North Atlantic sea ice where founding populations were eventually established in North America. After preliminary assessment and comparison of Solutrean and Clovis technology, as well as examination of paleoecological reconstruction of the LGM for Europe

and the North Atlantic, we feel that this hypothesis is most parsimonious with currently available data and warrants further study and serious consideration.

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CHAPTER TEN

THE FIRST AMERICAN LANGUAGES

Johanna Nichols



There are about 6,000 languages on Earth, falling into about 300 separate genealogical families and a wide range of structural types. About 150 of the families, and the full range of structural types, are native to the Americas. That is, half of the world's linguistic genetic diversity comes from this hemisphere, a vast bank of the world's linguistic and cultural wealth and a large body of evidence useful in tracing the origins of languages both American and non-American. Many of these American languages, and even several entire families, are now extinct, victims of the European conquest and its aftermath. Science and humanity are the poorer for these extinctions. However, the evidence available — the languages that have been or are being described, ethnonyms and wordlists for some that are otherwise unknown, oral traditions about ethnic identity, in some cases little more than indications of sheer difference from any other language — makes it possible to put together a bare-bones prehistory of the linguistic population of the Western Hemisphere. That prehistory seems to be consistent with what the speakers of the languages tell us: They have been in this hemisphere for a very long time, and they are above all American and not transparently recent imports from abroad. The kind of external origin that can be traced applies not to particular languages and families but, abstractly and probabilistically, to large geographically-based groups of language families. The languages of the west have affinities to languages around the Pacific Rim and those of the east have affinities farther south, with the languages of Melanesia and Australia.

The historical linguistic work done so far on the languages of the Americas has mostly involved establishing and reconstructing genealogical families. Such work is limited to the time frame within which the comparative-historical method used for detecting relatedness and reconstructing ancestral languages has any useful resolution — up to about the average age of the oldest families, defined below, and almost certainly not more than about 10,000 years even in the best of circumstances. Such work has almost nothing to

say about external connections of the native American languages, apart from showing that members of the Eskimo-Aleut family have spread from Alaska into Siberia in recent millennia and that the Austronesian colonization of the Pacific islands has not brought Austronesian languages to the Americas. Similarly, it has almost nothing to say about the initial colonization of the Americas, other than to point out that the large number of separate language families attested in the Americas seems far too high for colonization models that regard the Clovis culture or something in its time frame as the initial colonizer. This chapter takes a very different approach, one based on typological comparison and linguistic geography, for which external comparison and deep time depths are natural tasks, albeit at the cost of greatly reduced resolution as regards histories of individual language families. This approach does not trace or compare individual families at all, but deals with larger populations of language families and samples those populations by taking, typically, one representative per language family. For statistical comparison to be valid, a population needs to be large enough to yield about ten or more sample languages (and ideally distinctly more than ten). To avoid circularity, a population needs to be defined strictly geographically (and not by its component language families). Populations compared here include western North America, central to eastern North America, southern Mexico and Central America, western South America, eastern South America, northeast Asia, southeast Asia, etc.

The basic method used here is to compare frequencies of some structural element in the various populations. Quite often, frequencies of such features are not significantly different from population to population, so it is safe to assume that their levels and their variation are the result of universals and/or chance. Sometimes, however, the differences of frequencies from population to population significantly exceed what would be expected by chance, and when two populations both exceed chance expectation significantly and in the same direction (*i.e.*, both having either significantly more or significantly fewer tokens of the feature than would be expected by chance), then the resemblance is highly unlikely to be due to chance or universals. This means that chance and/or universals should not be our first choices for explanations of the resemblant frequencies. Rather, it is safe to hypothesize that they are due to some shared history: undetected deep genetic connections between some members of each of the populations, or common geographical origins of some of the members or indeed of the entire populations, or separate contacts of the populations or some of their members with a third party. It is generally not clear just what the shared history might have involved, but statistically significant sharings nonetheless mean that shared history in the abstract can safely be posited. That is the method used here. Below the term *affinity* will be used of situations in which two populations exhibit significant sharings of more than one structural property (and

the properties in question are independent of each other). This term contrasts with *genealogical relatedness* and *descent*, which are used when speaking of sharings due to inheritance from a common ancestor.

Linguistic Diversity in the Americas

The roughly 150 genealogical lineages of American languages are the kind of linguistic family I call the *stock*: the oldest traceable family for which standard linguistic comparative method can not only establish the fact of relatedness but also detect regular sound correspondences and therefore reconstruct sounds, words, and grammar elements of the ancestral protolanguage. The term *family* is a generic term for genealogical groups of all kinds (including stocks, which are a particular kind of family).

The oldest stocks tend to be about 6,000 years in age: Some examples are Indo-European, Uralic, Austronesian, Algic, Siouan-Catawba, Uto-Aztecan (the latter three American). Many are much younger, but are nonetheless self-standing stocks in that they have no provable outside kin and are therefore highest genealogical nodes: Examples are Hmong-Mien, Chumashan, and Kiowa-Tanoan (the latter two American). A few are older: Nakh-Daghestanian (or Northeast Caucasian) and Austroasiatic (see Blust 1996) are examples. Every language isolate (examples are Basque, Burushaski, or North American Zuni and Kutenai) is its own stock. It may be useful to distinguish between a stock's *internal* age, the time elapsed since its initial breakup, and its *external* age or *lifespan*, the age up to which it can be traced without detecting external kin. It can be assumed that any stock is likely to have deep kin connected to it at an age beyond the external age, but we cannot identify them. There is no uncontroversial purely linguistic means for determining the internal age of a family, although it is fairly easy to describe families as about Romance-like or about Oceanic-like (or Mayan-like) or about Indo-European-like in their diversity, using well-known families as reference points, and in this way to estimate their internal ages at around 2,000, 4,000, and 6,000 years respectively. Estimating stock lifespans is also not uncontroversial, but I will take 6,000 years, the average age of old stocks, to be the average stock lifespan. This figure is an average and an approximation, and it will be used only for modeling and simulation, procedures in which estimates and approximations are appropriate.

Some language stocks have many daughter languages: An example is Austronesian, with over 1,000 daughter languages. Some have few: Examples are isolates, which have one descendant each, as well as small families such as Northwest Caucasian (two to four living daughter languages and one recently extinct) or Yukian (in the Americas; two daughter languages).

Language stocks are not evenly distributed over the Earth. In the Americas, most of the genealogical diversity is found in the west. In North America, two-thirds of the language stocks are found along the western edge of the continent, between the coast and the coast range (Jacobsen 1989). Other high-diversity clusters are in northern South America (especially in the Amazon basin), Mesoamerica (southern Mexico and Central America), and around the Caribbean. Relatively few families are found in the Great Plains, the Northeast, and the Arctic and sub-Arctic. These patterns of diversity and non-diversity are not unique to the Americas but follow general principles that determine language-family diversity. Diversity is highest at lower latitudes, along coastlines, and in simpler societies; diversity is low at high latitudes, in continental interiors, in areas of dry or cold climate, and in complex societies (it is particularly low in areas with a long history of empire as in much of Eurasia and northern Africa) (Nichols 1990; 1992:232 ff.; 1998b; map of world language diversity, 1990:135.) Since the distribution of diversity in the Americas is the result of climate, geography, and economy, as it is elsewhere, it cannot reveal much about the history of colonization of the Americas.

The Age of the American Linguistic Population

There are several ways in which the statistical parameters of the linguistic population of the New World can be used to estimate the age of that population. (It may be important to emphasize that the procedures used here all yield estimates rather than precise ages. Therefore they are stated in approximate figures.) One estimate of age is based on average rates of language population growth (Nichols 1990, 1992, 1998a, 1998b, 2000b). The approximately 150 language stocks of the Americas are the result of immigration, subsequent proliferation, and extinction. A plausible rate of immigration from Siberia to North America via Beringia (the only entry point) is one language every two or three millennia (Nichols 1990), a figure based on attested rates of language succession in Siberia and Alaska over the last 5,000 to 6,000 years, language succession elsewhere at high latitudes, and rates of archeological cultural succession in southwestern Alaska since the Pleistocene. These are rates of successful immigrations, as they are based on succession rates for languages that have survived to be attested in their daughter languages and cultures which have survived to spread in Alaska and show up in the archeological record. Entry rates during the Pleistocene must have been slower, as glacial conditions made entry (and high-latitude living in general) difficult. During the height of glaciation, around 16,000–20,000 yr B.P., entry is likely to have been impossible.

While language families vary greatly in their internal ages and in the number of their daughter languages, their modal ages and sizes can be used for modeling purposes. The

stock lifespan of about 6,000 years, described above, will be used as an estimate of age. For stocks and old families, the average number of surviving initial branches is about 1.5 (Nichols 1990); about one-third of the world's language stocks are isolates. For working purposes it can be assumed that each stock represents a branch that split off from some ancestor about 6,000 years ago (its own internal differentiation may have begun much later) and each such stock has 1.5 surviving branches, each of which develops into a stock (with 1.5 branches of its own) in 6,000 years, and so on.¹

I performed a number of simulations using various rates of entry and proliferation, of which only three kinds of scenarios were able to yield approximately 150 daughter stocks: scenarios with 10–12 entries beginning 20,000–30,000 years ago (Nichols 1990), ones with one immigration about 50,000 years ago and no more after that (*ibid.*), and ones with a few entrants before the height of glaciation, several afterwards, and a faster rate of post-entry proliferation for the first entrant (Nichols 2000b). Varying immigration and stock proliferation rates within naturalistic parameters made relatively little difference in the outcome. The only simulations with naturalistic assumptions that gave appropriate outcomes began before or during the height of glaciation (and recall that actual entry during the very height of glaciation was probably impossible, so that a figure in this vicinity requires entry before the maximal glacial advance). Though all the component figures are approximate, these models indicate strongly that human settlement of the Americas began over 20,000 years ago.

The Monte Verde archeological site near Puerto Montt in southern Chile is dated at about 12,500 yr B.P. (Dillehay 1997; Meltzer, this volume). Nichols (1998a, 1999, 2000b) estimated rates of language spread from just south of the ice sheets to Monte Verde, along both coastal and intermontane interior routes, based on attested and reconstructible rates of language spread (using only spreads that did not utilize transport such as voyaging canoes or horse-drawn wheeled vehicles) through comparable ecologies. A beeline spread to Monte Verde with constant motion at the fastest plausible pre-transport rates would require at least 7,000 years, thus requiring an immigration by 19,500 years ago. In this way language spread rates point to entry during or before the height of glaciation, supporting the results of simulations based on proliferation rates. Since entry during the height of glaciation was probably impossible, the calculations from language spread rates can be interpreted as pointing to colonization beginning before the height of glaciation.

Nichols (1992, 1997, 1998a, 1998b, 2000b, 2001; Nichols & Peterson 1996) has described stratification in the linguistic population of the Americas. There is a relatively recent overlay along the Pacific coast, which is continuous with a similarly coastal population in Asia and Australasia and for that reason is termed the Pacific Rim population.

Then there is an older population (perhaps with some internal stratification of its own) distributed throughout the hemisphere and overlapping geographically with the Pacific Rim population. Here the older population will be called the *eastern* population, since it is the only occupant of the eastern parts of both North and South America (though it does not occupy only the east but is also found in the west). Evidence that the Pacific Rim population is the younger one comes from its more restricted distribution, its localization in the vicinity of the entry point, its continuity with populations which in Asia or Australasia spread after glaciation, and its high structural profile with several distinguishing grammatical markers. Especially good evidence is the clumpy distribution of those distinguishing markers in the Pacific Rim population. Grammatical features such as verb-initial word order and numeral classifiers, which have no inherent linguistic affinity and are not linked outside of the Americas, show a statistically significant tendency to co-occur in the same languages in the American Pacific Rim population. This clumpiness suggests that accidental combinations of properties that happened to occur in the ancestral languages still co-occur in their descendants. With enough time, language change will dissociate some of these clumps.

The older population has none of these characteristics: its range is the entire hemisphere, and it has no continuity with any nearby Asian or Australasian population, no affinity to any population resulting from a postglacial spread, no distinguishing markers not also found in the Pacific Rim languages, and no clumpiness of grammatical features.

The age of the Pacific Rim population will provide a benchmark for computing the time of first colonization, since the age of the entire American linguistic population is considerably greater than that of the Pacific Rim population. Nichols (in press) uses a sort of survival analysis to estimate the age of the Pacific Rim population. Average rates are estimated for inheritance, loss, innovation, and borrowing of several of the distinguishing Pacific Rim markers, and each marker is assumed to be brought in by a single ancestral entrant, which proceeds to proliferate at standard rates. Times required to reach the attested frequencies of the markers in Pacific Rim stocks range from over 12,000 yr to over 18,000 and almost 24,000 years. These figures are very rough because actual rates of inheritance, loss, innovation, and borrowing must be estimated from a small sample and because this technique is new and unrefined. Still, it can be said that these results suggest entry of the Pacific Rim population beginning late in the Last Glacial period or during the early waning of the ice sheets. On much firmer grounds, the Pacific Rim population in eastern Asia began to spread out into Melanesia in the same time frame (Nichols 1997, 1998:161 ff.). In both hemispheres the Pacific Rim spread seems to have represented the expansion and movement of a coastally adapted population as the climate improved and sea levels changed.

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Another way of estimating the age of the Pacific Rim population is to consider the numbers and ages of language families included in it. The North American Pacific Rim languages include the large grouping known as Penutian, for which a branching tree is shown in Figure 1. (This is based on my reading of DeLancey & Golla [1997] and other contributions in the same volume; no tree is given there, but the evidence presented in the individual articles, together with most of the prose statements, suggest approximately this tree). The subbranch known as California and Plateau Penutian seems to be a clear family, though probative evidence has so far been published only for the Miwok-Costanoan-Yokuts subset of it (Callaghan 1997; Callaghan's wording is cautious, but the evidence she presents impresses me as probative). Callaghan gives ages of Germanic-like (*i.e.*, *ca.* 2500 years) for Miwokan (1988:53, cited by Campbell 1997:129) and 4500 years for Miwok-Costanoan (Callaghan [1997] on both linguistic and archeological evidence) and perhaps 6,000 years for Miwok-Costanoan plus Yokuts. Golla (2000) considers these ages too high. The California-Plateau group consists of this branch plus three others, the interbranch articulation uncertain and the dispersal probably achieved by separate and successive migrations (DeLancey & Golla 1997 and other contributions in the same volume). Given the stock proliferation rate and stock lifespan, addition of three more branches in more than one step increases the age of the putative family considerably. This California-Plateau group is then possibly related in some fashion to a set of western Oregon families, again with uncertain articulation, and the age of the whole is correspondingly greater. Finally, the Tsimshianic family of central British Columbia is a more speculative connection; if related, it further raises the age of the larger group. The diagram in Figure 1 attempts to capture the branching structure of the firm core grouping and the likely structure if some of the others are taken to be kin.

At least some part of this large group forms a genuine linguistic family. Perhaps the best interpretation is to regard the California-Plateau core as a stock, with likely deeper kin whose actual genealogical status may never be fully specifiable. The older the grouping posited, the less its certainty. Nichols (1998a:163) estimated the age of Penutian at about 12,000 years, based on the average rate of stock proliferation; this of course is its age *if* it is a family, though calculating an age does not prove it is a family. Golla (2000) uses a sophisticated relativization of linguistic measures of age to sociolinguistics and considers the age of Penutian closer to that of Indo-European, with differences exaggerated by substratal effects and isolation of communities. Campbell (1997:309 ff.) rejects genetic relatedness for Penutian and even for the California-Plateau core of it. My own current impression is that the California-Plateau subgroup group is a likely family and close to (and no less than) Indo-European-like age, and some of the western Oregon

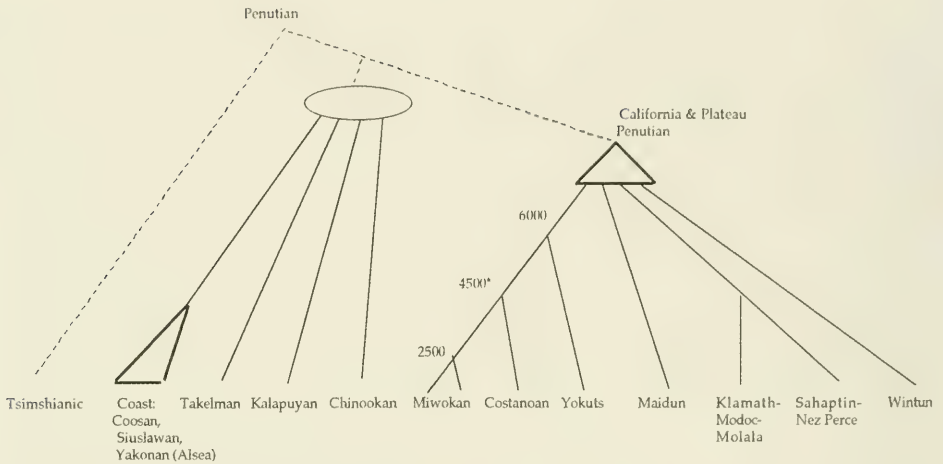


FIGURE 1. Tree structure for the Penutian languages. Triangle: Probable branch with uncertain internal structure. Dashed line: Connection debated. Ellipse: Branch status and internal structure (if any) uncertain. Numbers: Approximate dates, based on linguistic evidence, in yr B.P. * = Supported by archeological evidence as well.

languages are possible more distant kin. The Pacific Rim population is then old enough to contain this likely deep family and possible deeper kin as one small subpart.

Nichols (1990) used structural diversity of the linguistic population as a rough measure of age for colonized areas. The languages of Australia and those of New Guinea show great typological variety for most standard metrics, as is unsurprising: These lands have been inhabited for about 50,000 years, so there has been ample time for diversity to develop since settlement began. Furthermore, their colonization prehistories have involved many entries at different points and have drawn on the structurally and genetically diverse linguistic population of western Melanesia and pre-Austronesian insular southeast Asia, so the entrants themselves must have been a diverse population. The linguistic population of the Americas is nearly as diverse as these,² which is surprising, as there was a single entry route (via Beringia) and the colonization process drew only on the sparse linguistic population of high-latitude Siberia. That the diversity is so great indicates a long period of habitation, long enough for diversity to develop *in situ*.

Structural diversity, like genetic diversity, is lowered in spread zones — areas such as continental interiors, deserts, and high latitudes, in which different language families tend not to coexist but rather one language tends to spread widely at the expense of all others (for spread zones, see Nichols 1992:12–24). As Australia is almost entirely a vast

spread zone, its genetic and structural diversity are lower than those of New Guinea, despite the identical colonization dates and colonization histories of the two lands. Diversity is high in what are called *residual zones* in Nichols (1992; *accretion zones* in Nichols 1997), areas (mostly coastal and piedmont areas, and regions with mild climates) in which large language spreads are rare and diversity increases with each entrant and continues to build up. By accident of geography and climate, the Americas contain extensive stretches of such suitable territory for the development and preservation of high diversity. The Pacific coastline up to the eastern slopes of the coast ranges, the area around the Caribbean and the Gulf of Mexico, most of northern and central South America, and most of the southeastern U.S. These regions were able to act as a reservoir of diversity, preserving representatives of probably the great majority of stocks that entered or developed after colonization. In view of this large diversity bank, survival rates and diversification rates give a good estimate of the time of habitation for the Americas.³

The Geographical Origin of the American Linguistic Population

The Pacific Rim population of American languages has a number of structural affinities with the languages of the Asian Pacific coast and northern Melanesia, and these make it possible to identify a greater Pacific Rim population extending across the Melanesian, Asian, and American Pacific coasts. Several grammatical markers are of relatively high frequency in the greater Pacific Rim population and rare or virtually nonexistent elsewhere. Numeral classifiers and personal pronoun systems with first person *n* and second person *m* are virtually nonexistent outside of the Pacific Rim population, verb-initial word order is rare elsewhere, and true cases and suffixal person agreement are common in Eurasia but rare in the Americas except in the Pacific Rim.

The Pacific Rim features are purely typological properties except for the *n* : *m* pronoun system, for which it is natural to suspect inheritance and hence to posit deep genetic relatedness for the language families exhibiting it. Nichols and Peterson (1996) consider the statistical value of such a system and show that it is not sufficient evidence on which to base a claim of genetic relatedness. On the other hand, the difference in frequency of such pronominals between the Pacific Rim population and others (including between the American Pacific Rim population and the American eastern population) is statistically significant, which means that the high frequency in the Pacific Rim languages is highly unlikely to be due to chance or the operation of language universals. (Genetic relatedness and language universals exhaust the explanations offered of this distribution in the prior literature.) Nichols and Peterson conclude that the *n* : *m* pronoun system is the result of a single historical event, though the surviving evidence does not indicate

what kind of event. Nichols (2001) argues that patterns like the $n : m$ one are non-universal phonosymbolic canons sometimes found in small closed sets of words or formatives, and that they are favored in both inheritance and areal transmission. That is, they are fairly unlikely to arise but, once present, are quite likely to be inherited and somewhat likely to diffuse; the likelihood of transmission of some kind (inheritance, diffusion) is greater than the likelihood of the feature arising in the first place. If this is so, the $n : m$ system has spread in the Pacific Rim population by both diffusion and inheritance from some single source. Some, but not all, of the stocks with some representation of $n : m$ systems are likely to be deeply genetically related. The language in which the first $n : m$ system originated was probably spoken in northeastern Asia (to judge from the frequency of phonosymbolic pronominal systems, albeit not of the $n : m$ type, in northeastern Asia). There are a few tokens of $n : m$ systems in the Asian and Melanesian Pacific Rim languages, but not enough to significantly exceed chance. Therefore the first $n : m$ system must have arisen in a language or language population on its way into the New World, and the spread of the system by diffusion and inheritance took place mostly in the New World.

The other Pacific Rim markers, however, are well attested in the Asian and Melanesian Pacific Rim languages and not only in the Americas. (See Maps 9 and 10 in Nichols 1998b, or Maps 12 and 13 in Nichols & Peterson 1996.) The population bearing these markers must have formed somewhere in coastal eastern Asia, and its component languages evidently spread in two directions: northward and eventually into the Americas, and southward and eventually into Melanesia. (That these two trajectories of language movement and human migration existed is beyond doubt.) Now, millennia later, Pacific Rim features ring the Pacific from Melanesia to eastern Asia to the western Americas. It is probably worth emphasizing that this pattern is the result of movement along coasts (and, in Melanesia and Australasia only, movement from island to island) and not overwater contacts between Asia and the Americas. The human settlement of the Polynesian islands (along which any such overwater contacts would have had to occur) took place only in the last two millennia, and before that the Polynesian islands were uninhabited and almost certainly untouched by humans (*e.g.*, Kirch 2000).

Markers of the eastern population include head-marking morphology (and in particular the otherwise rare radically head-marking type), prefixal person agreement, identical singular and plural stems in personal pronouns, and simple consonant systems (sometimes containing only a single manner of stop articulation). These features are well attested in Melanesia and especially Australasia. Head marking is fairly common in New Guinea and northern Australia; prefixal agreement likewise; identical singular and plural stems likewise; and simple consonant systems are relatively frequent in New Guinea and

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nearly universal in Australia. Unlike the Pacific Rim features, these markers are common in interior (highland) New Guinea and Australia, *i.e.*, farther from the (northern, coastal) entry point than the Pacific Rim features, so that in their geography they appear to be earlier entrants than the Pacific Rim markers. They are missing from the coastal east Asian staging area that fed the migratory trajectories leading on the one hand to Melanesia and on the other to the Americas. In all these respects they appear to be markers of earlier colonizers, now found only at the far ends of the two trajectories.

The best interpretation of all the facts would seem to be that both strata of the American linguistic population originated somewhere in eastern Asia (probably in the same general area but at different times). Colonizers of America at all times appear to have mostly been coastally adapted people. There is no linguistic evidence for a substantial contribution from inner or central Asia to the American linguistic population. The main connections are to Southeast Asia and Melanesia.

Post-colonization Developments

After entering North America, the Pacific Rim population evidently spread coastally, eventually extending to southern South America and hugging the coast with almost no eastward spread. In the last few millennia, a north-to-south trajectory is the most common one for language families in North America on or near the coast. The coastal Athabaskan languages and most of the California-Plateau Penutian groups have all spread mostly southward from their points of origin. (For languages and families mentioned here and below, see Campbell 1997: chapters 4–6 and Goddard 1996. Their ranges are shown on the map accompanying Goddard 1996. For Athabaskan see also Leer 1991. For Penutian see also DeLancey & Golla 1997.) The Athabaskan family originated in the subarctic (southern Alaska to northern British Columbia according to Leer 1991), and its Pacific Coast languages extend like beads on a string from Washington to northern California. The Penutian languages probably originated on the Columbia Plateau and spread, in a series of migrations, into Oregon and California. This history is accepted for the Wintun, Maidun, Miwok-Costanoan, and Yokutsan branches (Whistler 1977) and is a plausible trajectory for the possibly Penutian languages of western Oregon regardless of whether they are actual genetic kin.

If the pre-Pacific Rim entries were also coastal — and it seems increasingly unlikely that any interior corridor was open to immigration and inviting to immigration during glaciation — then it is likely that once in North America they too spread coastally southward. This would mean that they spread from inhabited to uninhabited lands and that they kept to the coastal ecologies with which they were most familiar. Systematic settlement of the interior must then have begun after the end of glaciation. The spread of the

Clovis culture (see Meltzer, this volume) marks one of the first expansions into the interior, and perhaps the very first.

Colonization of the interior is likely to have come from the south. One piece of evidence for northward spread into the interior is the fact that in historical and reconstructable times the language families of the mid-latitude interior of North America have mostly spread from south to north. Prominent examples are the Uto-Aztecan family, which spread from approximately northern Mexico to southern California and the Great Basin (again, see relevant sections of Goddard 1996 and Campbell 1997; also Madsen and Rhode 1994); the Siouan-Catawba family, which spread probably from the vicinity of the lower Mississippi to form enclaves in various parts of the southeastern U.S. and well north along the Missouri, Mississippi, and Ohio valleys (the northernmost members are Stoney and Assiniboine, both spoken in southern Canada); and Caddoan, which probably also originated in the vicinity of the lower Mississippi and spread far north into the Great Plains (its northernmost language, Arikara, is spoken in North and South Dakota). (Of these, the Uto-Aztecan spread in the Great Basin was a spread of non-farming people; the others were spreads of agriculturalists.) Even the Algonquian family, which spread primarily eastward probably from the vicinity of the Columbia Plateau (Goddard 1994), once east of the Rocky Mountains underwent considerable northward expansion so that in historical times it occupied much of central Canada. If Leer is right about the west central Canadian origin of the Na-Dene family, then its mostly interior Athabaskan branch has spread far north of this origin. The only important exception to the mostly northward drift in the interior is offered by Navajo and the Apachean languages spoken around the periphery of the pueblo area in the southwestern U.S.; they are the result of southward migrations from southern Canada within the last millennium.

These examples of northward drift in the interior are based on language-family spreads, and pertain only to the last several millennia. Uto-Aztecan and Siouan-Catawba, two old language families of the interior, are both of about Indo-European-like age, *i.e.*, about 6,000 years old at most. Movements in this time frame do not directly testify to directions of movement shortly after the end of glaciation, and furthermore the largest northward spread, that of the Siouan language family, involved farming people. Still, it is more parsimonious to assume that this northward drift continues a long-standing tendency rather than a recent development. Then the standing northward drift among language families in interior North America may provide indirect evidence that humans claimed interior North America after glaciation in northward movements. The source of these movements must have been in the vicinity of the Gulf of Mexico.

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There has also been some west-to-east movement bringing representatives of coastal and near-coastal families into the interior. The Athabaskan-Eyak-Tlingit family⁴ originated near the coast or on the eastern slope of the coast range somewhere from southern Alaska to central British Columbia, and its Athabaskan branch spread mostly eastward to cover most of interior central and northern Canada and all of interior Alaska. The Salishan family originated on or near the coast in northern Washington to southern British Columbia, and its interior representatives extend to Idaho and Montana. The Algic family probably originated on or near the Columbia Plateau, and its descendants now comprise Yurok and Wiyot of coastal northern California and the geographically vast but temporally shallow Algonquian family, which extends from the western Great Plains (Plains Cree, Blackfoot, Cheyenne, Arapaho) to the eastern seaboard (Montagnais, Micmac, Delaware, etc.). Thus the entire non-Pacific part of North America — the Great Basin, the intermontane area, the Great Plains, the eastern woodlands and seaboard — have received some of their language population from the far west, while the converse does not hold (Jacobsen 1989).

To summarize, the settlement of the Americas involved three main trajectories. Immigrants from Siberia spread southward, chiefly along the coast; from time to time, a language spread eastward into the interior; and, since the end of glaciation there has been northward and eastward movement into interior North America.

Network analysis of the distribution of structural markers in the Americas supports this general picture of multiple trajectories and a secondary hub in the vicinity of the Gulf of Mexico. Nichols (2000a) divided the American languages into five large areal populations (western North America extending to the Rockies, eastern North America from the Rockies to the Atlantic, Mesoamerica, *i.e.*, southern Mexico and Central America, western South America, and eastern South America) and compared the frequencies of various structural features, comparing each areal population to all the others and to 12 areas of comparable size worldwide. For example, the proportion in each area of languages of the radically head-marking type was compared (as high, moderate, or low relative to the worldwide mean), and two areas were judged to have an affinity with regard to that marker if they both had high frequencies. The higher the number of such affinities, the stronger the overall affinity of the areas. Languages used for comparison were those in a 200-language family-based worldwide sample. In the comparison of the American areas to others, no strong evidence of Siberian affinity appeared. The five American areas, individually and collectively, find their closest affinities in Melanesia, with northern Asia a distant third or fourth. A diagram of the connections among just the American groups is shown in Figure 2. The five American areas form a network with a hub centered in the vicinity of the eastern Gulf of Mexico and/or the eastern

Caribbean, from which connections reach out in various directions. Mesoamerica, eastern North America, and eastern South America are a closely linked network, with eastern North America in particular so closely connected that it is virtually an offshoot of Mesoamerica. Western North America is more distant, and western South America still more distant and very much off by itself. There is as yet no way to assign a chronology to the formation of this network; it could reflect the spread of agriculture from its Mesoamerican origin, colonization of the interior after the end of glaciation, or both. Regardless of its exact chronology, the network diagram shows that the main factor in the distribution of linguistic elements in the Americas was not the process of immigration from Siberia but much later developments reflecting the formation of and expansion from a hub far to the south of the Alaskan entry point.

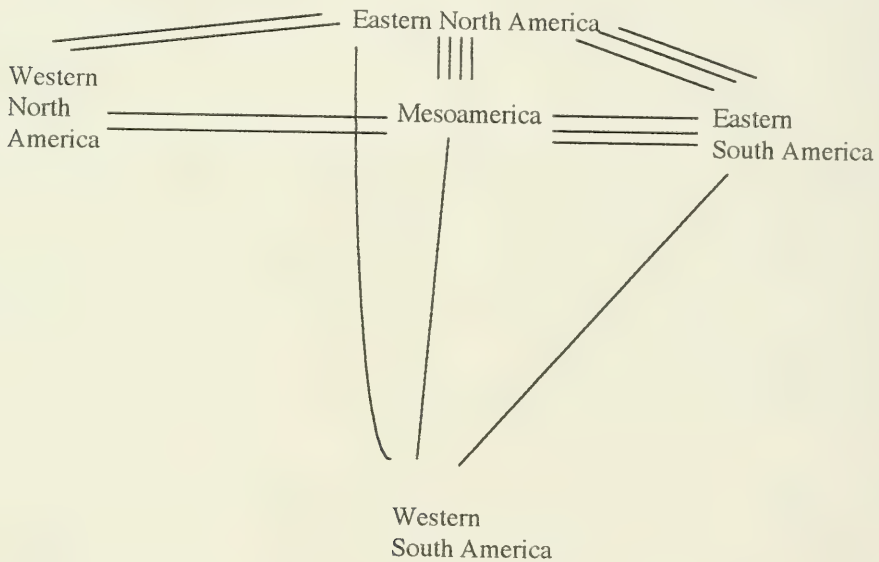


FIGURE 2. Network of interareal linguistic connections in the Americas. Based on 8 non-Pacific Rim structural features. One line denotes a shared high frequency for one feature. The length of a line reflects distance in schematic space.

The Languages of the First Attested Americans

Unless there is inscriptional evidence of the language, there is generally no way to know what language was spoken by a given prehistoric individual or culture. On the

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other hand, it can be asked, for any language or language family, whether its ancestor might have been spoken by some particular ancient society, and with what likelihood. This section is a rather speculative attempt to list some of the language families whose distant ancestor might have been spoken by each of four ancient individuals or cultures: the Kennewick Man, the Monte Verde people, the Channel Islands Woman, and the Clovis people. Of course, there is always the possibility that the language of any of these has gone extinct leaving no modern descendants.

The Kennewick Man died a little less than 10,000 years ago near the Columbia-Snake River confluence and, thus, on the Columbia Plateau and close to the coastal area. The Columbia River itself has served to connect the two cultural provinces in historical and reconstructable times, and must have done so in the Kennewick Man's time as well. In this time frame and this area his language could have belonged to either the Pacific Rim or the eastern population. His language might well have been the ancestor of Penutian (or whatever part of that group may eventually prove to be a family), or the distant ancestor of the Algic family, both of which are regarded as having spread from the Plateau. His language might have been a pre-Penutian, pre-Algic dispersant from the Plateau, in which case its descendant(s) might be found anywhere beyond the frontier of either Penutian or Algic — southern California, Washington, British Columbia or, given the vast eastward stretch of Algonquian, virtually anywhere in intermontane or eastern North America. Or his language might have been caught in the northward drift of the interior languages and moved far north; it could, for example, have reached northern British Columbia or Alaska and ended up as Proto-Eyak-Athabaskan-Tlingit (some of whose descendants have moved south to end up not far from the Kennewick Man's resting place). A pre-Penutian dispersal along the Penutian trajectory, into interior California, could have produced any of the Hokan languages of the northern and central California hills and mountains (these include the Pomoan family, Shasta, Washo, Karok, and others). Or, moving at the rate at which the Pacific Coast Athabaskan languages traveled from southern California to northern California, or the rate at which the various Penutian languages of California have spread, his language might have moved southward to anywhere from Mexico to southern Central America or even South America. In short, the Kennewick Man's language might with equal plausibility have been ancestral to nearly any language family of North America and possibly Central and South America as well. That is, a few different stocks might descend from his language, and nearly any American stock is a candidate for one of those descendants. We will almost certainly never have any indication as to just which stocks those might be.

The Channel Islands Woman lived about 13,000 years ago on Santa Rosa Island offshore from southern California. These islands hosted languages of the Chumashan and

Uto-Aztecan families in the historical period, and Santa Rosa Island was specifically Chumashan-speaking. The Uto-Aztecan family originated probably in interior northern Mexico some five millennia ago. The Chumashan family is a very shallow one which originated on the mainland. Though it is possible that the distant ancestor of Proto-Chumashan was spoken where its distant descendant was, it is not likely that any one language has stayed in place for so long. That is, the Channel Islands Woman is not likely to have spoken anything ancestral to modern Chumashan, though the possibility cannot be excluded. Similarly, it is unlikely, though it cannot be excluded, that a distant ancestor of Uto-Aztecan was spoken here and its descendant ended up many millennia later in Mexico as Proto-Uto-Aztecan, whose own later descendant happened by coincidence to end up 13,000 years later in a place where the distant ancestor had been spoken. Any other language family in the Americas, but especially the western Americas, might with equal likelihood descend from the early Channel Islands language. At 13,000 years ago the island language might have been one of the very first Pacific Rim languages to spread south, or it might have been a language of the earlier, eastern population that remained in the coastal area during and after the Pacific Rim spread.

The Monte Verde people, as far south as they were at 12,500 years ago, could hardly have spoken a Pacific Rim language; at that time the Pacific Rim languages had only just begun their spread into coastal North America. Too little is known about trajectories of language spread in South America to support a guess as to where the descendants of the Monte Verde people's language might now be. As a language near the far end of the colonizing thrust and not in an obvious spread zone that might have impelled its descendants far in various directions, it is relatively likely to have gone extinct.

The Clovis people, beginning about 11,500 years ago, spread out rapidly over a large area in the interior southern half of the U.S. (see Meltzer, this volume). Their range is much larger than usual for languages of pre-farming, pre-transport societies at its latitude, though it is comparable to the range of Cree, the northernmost Algonquian language, which extends across eastern and central Canada. Of course, conditions in the Clovis range at the Clovis time must have been rather like those in central Canada in recent millennia. That is, the Clovis range was almost certainly a spread zone, and the Clovis people could have spoken a single language and are likely to have spoken one or more languages belonging to a single family. The Clovis language(s) could have left descendants in one or more places in or at the frontier of the range of the Clovis culture, and these could have been caught up in the trajectories of northward drift, coastward drift, and southward movement along the coast. The language of the Kennewick Man might well, on chronological and geographical grounds, have been a descendant of a Clovis language. By now, virtually any language of North America, Mexico, or Central

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America, other than those with Pacific Rim features, might with equal plausibility descend from the language (or languages) of the Clovis culture.

The languages of these four individuals or cultures, if they survived, have had about two 6,000-year stock lifespans in which to reproduce. The language of the Kennewick Man and (especially) that of the Clovis people were spoken in important spread zones and are likely to have had more than the average 1.5 descendant stocks. The language of the ancient Channel Islands and ancient Monte Verde was spoken in residual zones and are likely to have had fewer than the average number of descendant stocks, in view of its geography. The Monte Verde language, as mentioned, is the most likely of these four to have gone extinct.

The Clovis language in particular could have had several surviving descendants, as has generally occurred with languages spoken by societies entering new ecological or economic niches. Each of these branches would then have given rise to its requisite stock or two, so that by modern times a number of different stocks — perhaps a dozen — might be descendants of the Clovis language. At least half might still be in North America. At a time depth like 11,500 years one would expect the descendant stocks to retain some suggestive resemblances, though not precise enough or numerous enough to firmly indicate genetic relatedness. This hypothesis can therefore be suggested to Americanists: Half a dozen language stocks, scattered widely around North America, plus a few more stocks from points south, descended from the Clovis language. They belong to the eastern linguistic population (though some of them may be physically located in the coastal area), and lack most or all Pacific Rim features. The northernmost stocks of this ancient family have mostly been swallowed up in the spread zone of the northern North American interior which is responsible for the Athabaskan and Algonquian spreads in the northern U.S. and Canada (though Proto-Na-Dene, the ancestor of Proto-Athabaskan, could on geographical and typological grounds belong to the Clovis descendants), but the vast accretion zones of the west and southeast should have preserved several others.

It is also possible that the Kennewick Man, the Channel Islands Woman, and any randomly chosen individual of either the Monte Verde or Clovis culture was bilingual or multilingual, and/or that their larger communities were bilingual or multilingual. The Columbia Plateau is a center of not only language spread but also language contact, and of all four cases the Kennewick Man is most likely to have been bilingual and to have belonged to a bilingual community, a consideration that doubles the number of his possible linguistic descendants. The Channel Islands Woman, as a member of a coastal culture, is likely to have lived in societies so small that intermarriage was common, and is particularly likely to have married into a community speaking a different language from

her first language and to have raised children bilingual in her language and that of her husband. This consideration doubles the number of her possible linguistic descendants.

All in all, each of these four ancient languages might have a few surviving descendants among the 150 stocks and 1,000+ languages of the native Americas, and that of the Clovis people might have several. Conversely, virtually any recent native American language has a small probability of having descended from one or another of these ancient languages. Descendants of the Channel Islands language are most likely to be Pacific Rim languages, descendants of the Monte Verde and Clovis languages are almost certainly not Pacific Rim languages, and descendants of the Kennewick Man's language could equally well belong to the Pacific Rim or eastern populations.

Conclusions

From the perspective of the method used here, the main events or situations that have shaped the identity of the American linguistic population are their origin in the language population of Asia, chiefly coastal Asia; an early date of first colonization of the Americas; the appearance of the Pacific Rim population in the Americas as the ice sheets waned, and its rapid southward spread along the coast to southern South America; the large areas of high linguistic diversity in the Americas, and the consequent interaction and convergence that have resulted from long contacts among different languages; the probably long-standing importance of the lands around the Gulf of Mexico as a source of linguistic influence and movements; the expansion of the Clovis language or languages shortly after the end of glaciation, and its probable (but so far undetected) disproportionate representation among the language families of the Americas, particularly North America; the development of agriculture in Mesoamerica and (independently) South America; and the probable spread of languages out from these centers of agriculture. The origin of the linguistic population in Asia plays a small part in the distribution of structural features among the American languages. The primary shapers of their structural types, their geographical distribution, and their patterns of genetic relatedness have been post-colonization factors: the American geography, the centers of spread and diffusion that formed as a result of that geography, the interaction among languages in those centers, the rise and spread of agriculture, and the recent histories of various language families. It is in this sense that the American languages must be regarded as first and foremost indigenous and American.

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Abstract

At first European contact a tremendous number and variety of languages were spoken in the Americas: over 1,000 languages falling into nearly 150 separate families, and exhibiting a great diversity of structural types. This linguistic diversity sheds light on the origin and prehistory of the speakers of the languages. Where did they come from? Did they come in many immigrations, or has the diversity developed since entry? How long have they been here? Which of them have been here longest? Where and how did they enter, and what route did they travel once they entered? What languages were spoken by the earliest archeologically attested Americans?

Linguistic comparison can give increasingly firm answers to these questions. The languages (and their speakers) came from Siberia, and they had spread into Siberia from the south, perhaps from coastal southeast Asia. They developed here by both immigration and slow divergence. The longest-resident types can be identified by their grammatical structures and geographical distribution. Entries began at least 20,000 years ago. People entered via the Alaskan coast and spread coastally southward more often than inland. We cannot identify the individual languages spoken by particular ancient peoples, but we can make probabilistic statements about their possible modern descendants.

The evidence for earlier and later immigrants is subtle and requires close examination, as the languages have been shaped and situated primarily by interactions with each other and by long residence in their present locations. The native American languages are first and foremost indigenous and American, and the ancestors of even the most recent entrants were in America before the ancestor of any present European language is likely to have entered Europe.

Endnotes

¹ Both the immigration rate and the proliferation rate are survival rates, *i.e.*, actual immigration or proliferation minus extinctions. Nettle (1999) incorrectly assumes they are attempt rates rather than success rates, and that both the average stock age and average proliferation rate are precise figures and constants rather than approximations and averages.

² In their relatively high frequencies of head-marking types and inclusive/exclusive pronouns, the American languages show founder effects reflecting the limited and broadly Asian sources of their colonizers. The founder effects shift the frequencies of various types, but do not reduce the overall range of types.

³ Nettle (1999) proposes a model whereby in a given area or continent genetic diversity increases for a short time and then begins to decrease, so that less diversity points to greater age. This might be correct if all continents were like Australia — conducive to spreading and not large — so that a combination of spreading and convergence could decimate their language stocks. Australia is unusual, however, and except in the case of small islands most colonized areas had not yet reached the saturation point, when diversity starts to decline, by the time of European contact. Even if Nettle is right that diversity eventually starts to level off, it does so only in response to ecological and economic limits that are so much more important in determining diversity that a model based on them alone quite efficiently predicts existing linguistic diversity.

⁴ Often called Na-Dene, though that label is often used of a putative larger group also including Haida.

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CHAPTER ELEVEN

A MITOCHONDRIAL PERSPECTIVE ON THE PEOPLING OF THE NEW WORLD

D. Andrew Merriwether



In this volume, much has been discussed about the Pleistocene peopling of the New World, and the different sorts of evidence that could be brought to bear on questions about the number of migrations, origins of the founders, routes of entry, and especially the timing of entry of human populations into the New World. Among the major theses proposed in this volume, and elsewhere, are the following somewhat conflicting scenarios: 1) There were three waves of migration into the New World, corresponding to the Amerind, Na-Dene, and Eskaleut language groupings as described originally by Greenberg *et al.* (1987) and Greenberg (1986). 2) There was a single wave of migration into the New World, followed by differentiation of languages and peoples *in situ*, as argued by Merriwether *et al.* (1995), Kolman *et al.*, (1995), Forster *et al.* (1996) and others. 3) There was a separate pre-Columbian European migration into the New World, possibly by boat along the ice-sheets of the North Atlantic, as argued by Stanford (this volume), and possibly supported by Brown and colleague's (1998) X mtDNA haplogroup. 4) The Clovis hunters were the first humans in the New World (see discussion in Meltzer 1993; Meltzer & Dillehay 1998). 5) There were pre-Clovis, non-Clovis peoples in South America before and concurrent with the first Clovis sites in North America, representing an earlier migration. 6) There was a coastal migration, probably making use of boats (Erlandson, this volume; Nichols 1995). 7) There was an overland migration through an ice-free corridor in western Canada (see discussion in Meltzer 1993). 8) The founders came from the Mongolia/Southern Siberia/Manchuria/Lake Baikal region of Northeastern Asia (Merriwether *et al.* 1996; Kolman *et al.* 1995; Neel *et al.* 1994; Schurr *et al.* 1999; Starikovskaya *et al.* 1998).

Haplogroups, Haplotypes and Founders

A brief description of mtDNA nomenclature and definitions of the ubiquitous mtDNA haplogroups in the New World are necessary before the above scenarios can be evaluated using mtDNA data. First of all, a haplotype is any pattern of linked polymorphisms. Since there is no recombination in mtDNA, and since mtDNA is strictly maternally inherited (Case *et al.* 1981; Merriwether *et al.* 1991; Giles *et al.* 1980), any polymorphisms found on the mtDNA molecule from one individual may be grouped together into a pattern called a haplotype. This may be either a stretch of continuous sequence of mtDNA, or it may be a collection of restriction fragment length polymorphisms (RFLPs) from across the entire 16569 nucleotide sequence spanning the circular mtDNA molecule (Anderson *et al.* 1981). A haplogroup is a collection of closely related haplotypes that all share one or more mutations in common as compared to other haplogroups. In the New World, Wallace and colleagues (1985) were the first to show that Native Americans had a subset of mutations found in Asia, and at drastically different frequencies, implying a "dramatic founder effect" between Asia and the New World. Schurr and colleagues (1990) showed that 97% of the variation found in three populations from North, Central and South America fell into four distinct clusters. Wallace and Torroni (1992) labeled these clusters A, B, C and D. These were initially defined by RFLPs and one 9-base pair deletion. Specifically, haplogroup A was defined as having a *Hae III* restriction site gain at nucleotide (nt) 663. No other Native American groups possess this mutation. Similarly, haplogroup C was defined by the loss of a *Hinc II* restriction site at nt 13259, and haplogroup D was defined by the loss of an *Alu I* restriction site at nt 5176. Haplogroup B was defined by a deletion of 9-base pair of DNA from Region V of the mtDNA genome (a short noncoding stretch between the genes for cytochrome oxidase II and the tRNA for lysine). Most humans have two copies of this 9-base pair sequence tandemly repeated, but those in haplogroup B only have one copy and are referred to as 9-base pair deleted. Haplogroups A and B (and Brown's X) lack cuts at *Alu I* 10397 and *Dde I* 10394, while haplogroups C and D (and X6 and X7) cut at both sides. *Alu I* 10397 is very Asian-specific, and is found only in populations or individuals of Asian descent (including Pacific Islanders and Native Americans). The *Hinc II* 13259 site loss is always accompanied by the 10394 and 10397 site gains in the New World and Asia. While some populations outside of Asia possess the 13259 loss, they do not cut at 10394 or 10397. The 9-base pair deletion appears to have arisen a number of times, including at least once (and probably several times) in Africa (Soodyall *et al.* 1996; Chen *et al.* 1995; Vigilant *et al.* 1989, 1991; Redd *et al.* 1995) and at least twice in Asia (Ballinger *et al.* 1992; Torroni *et al.* 1993a, 1992; Redd *et al.* 1995). However, in Asian-

derived populations, 99% of those with the deletion are derived from a single deletion event, probably 30,000 to 60,000 years ago. The other deletions tend to be rare. In addition to the RFLP markers, there are point mutations in the control region (the noncoding region of the mtDNA located roughly between nts 15975 and 430) that also can be used to define the A, B, C, D and X clusters (Merriwether *et al.* 2000a; Torroni *et al.* 1993a; Ward *et al.* 1991; Ginther *et al.* 1993; Kolman *et al.* 1995, 1996; Lorenz *et al.* 1997; among many others).

Which Way?

So what can mtDNA (or genetic evidence of any kind) say about these hypotheses? Of the scenarios above, proving routes may be the most difficult using genetic data, although a caveat would be that ancient DNA from humans along these routes could provide powerful evidence for or against some of these ideas. Nonetheless, we can see if the mtDNA data are consistent or inconsistent with any of the hypotheses. Certainly 99% of all Native American DNAs, from North, Central and South America are descended from types found in Asia. There are between 5 and 10 haplotypes that have been argued to be shared between the New World and Asia, which belong to 5–7 haplogroups (A, B, C, D, X6/X7, Brown's X). Five of these haplogroups appear to be widely accepted (A, B, C, D, and Brown's X) while two of the (X6/X7) are not as universally accepted and are closely related to C and D (see Merriwether 1999 and Merriwether *et al.* 2000). About 98% of all Native Americans sampled to date are A, B, C, or D (as defined by Wallace & Torroni 1992). The remaining 2% appear to be X6/X7 (as defined by Easton *et al.* 1996 and Merriwether & Ferrell 1996) or Brown's X (Brown *et al.* 1998). So the vast majority of all living Native Americans, regardless of tribal origin, language, or geographical location in the New World, are a variant of A, B, C, or D (see Figure 1). The ancient picture is much, much spottier, but almost everyone that has been fully typed for founding lineage markers in ancient populations has been shown to be A, B, C, D, or one of the X's. Coastal routes and oversea routes may leave no archaeological trace, especially if what was the coast is now underwater (or far inland). Certainly the proposed cross-Atlantic ice sheet route cannot be tested by almost any method.

When?

The idea of using a molecular clock to date the migrations into the New World is somewhat problematic when the time scale is so short (in evolutionary time 10,000–30,000 years is very short indeed). This is because the molecular clock assumption requires mutations to be random, not under selection (except for purifying selection

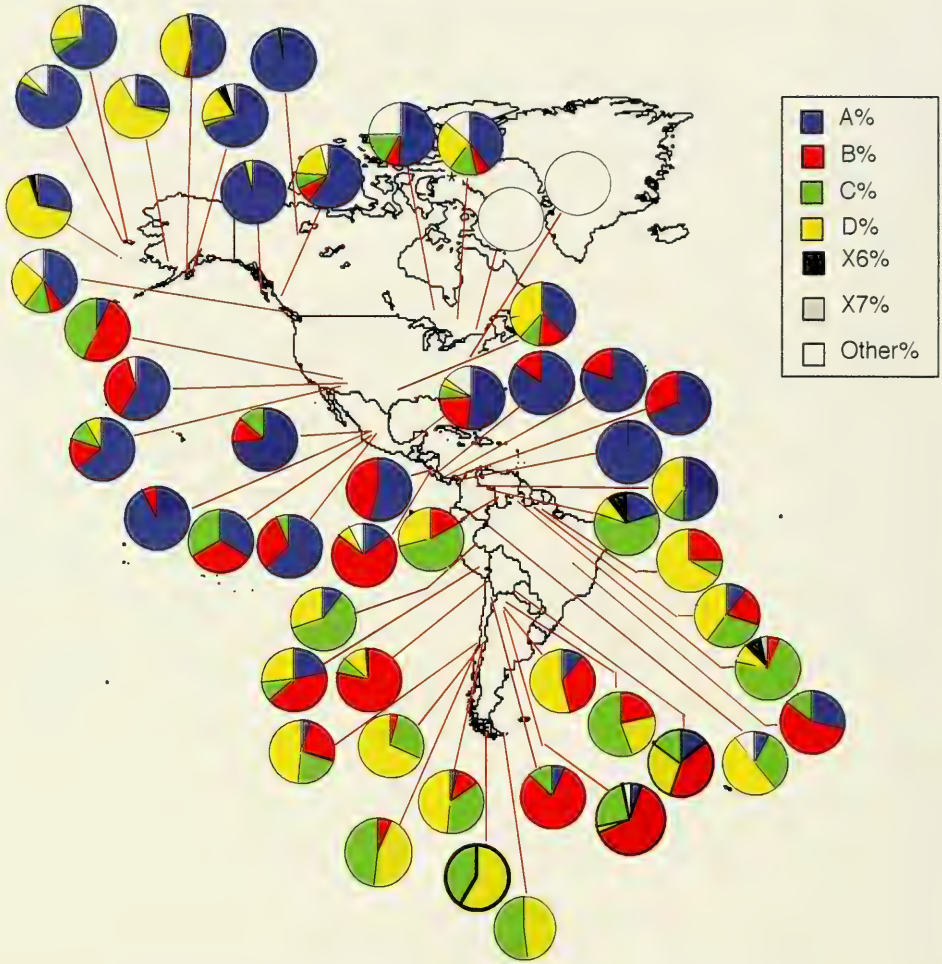


FIGURE 1. Frequencies of the founding haplogroups in the Americas.

against extremely deleterious mutations), and accumulating in a roughly clock-like fashion in all lineages. The problems with these assumptions are: 1) The clock is less accurate over short time scales. This is because mutations do not really occur at set intervals. Rather, the biochemical changes that create mutations are caused by errors made in replication and by environmental insults to the DNA and/or faulty repair of the damage. These different sources of error all play into the mutation rate. So if we expect to see one mutation every 6,000 years, as for some parts of the mtDNA, then on average after

6000 years in a population, we would expect most people to be one mutation different from each other, but many will have had none and many may have had two. Either way, over longer periods of time, the average number of mutations per year per nt becomes a stable number, assuming other factors are held constant. 2) A rapidly growing population in a new niche, without population pressures, may allow new mutations to enter the population more easily. This is because the new populations would be small, so any new mutation is automatically at higher frequency than if it had occurred in a large population (*i.e.*, a new mutant in a mtDNA population of 10 is now at 10%, while a new mutant in a population of 1000 is at 0.1%). If everyone is having lots of offspring, since there is endless space for them to live (at least early on in the peopling event), a new mutation is likely to increase rapidly. 3) As with fossils, we may always find some sequences that are divergent from all others that were missed initially due to inadequate sampling. There are currently estimated to be over 2.5 million Native Americans in North America (Thornton 2000) and probably 10 million or more in North, Central, and South America combined. At the time of contact, Butzer (1992) placed the total population of the New World at 43–65 million people. By the 1500s, the hemisphere as a whole was estimated to have experienced an 89% reduction in the Native American population (Denevan 1992). So we have mtDNA sampled a few tenths of a percent of the entire living Native American population, and less than a hundredth of a percent of the deceased Native population. Worse than this, we have sampled mtDNA from only a tiny fraction of the individual languages found in the Americas, although at least a third of the higher order groupings of languages have been sampled. So missing data, as always, could change the picture dramatically. 4) Once we have identified the mutations, and the mutation rate we wish to apply, there is still the problem of identifying which mutations occurred in the original parent population prior to migration, and which occurred in the daughter population after the migration. In the most likely scenario, this means which mutations are found in both Asia/Siberia and in the New World. The problem with this is that we can never be sure we have typed all the relevant individuals and populations. Indeed, if the parent population existed 30,000 years ago, some shared lineages between the New World and Asia have gone extinct in Asia. Either way, most published estimates of the age of the mitochondrial lineages in the New World have not accounted for mutations shared on both sides of the Bering Strait, and those have overestimated the time to a common ancestor for New World lineages.

With all these caveats in place, Torroni and colleagues (1992, 1993a, 1993b, 1994a, 1994b) have suggested that the average time to a common ancestor for each of the New World haplogroups is ~25,000 yr B.P., although the authors have argued for multiple migrations for this scenario, and that haplogroup B appeared to be younger than A, C,

and D. However, Bonatto and Salzano (1997) showed that the divergence times for A, B, C and D were not statistically different from one another. The 25,000 yr date is the time to a common ancestor in Asia, not necessarily the time to entry into the New World (which could be considerably younger).

Number of Founding Lineages (and Founders)

As early as 1985, most of the founding haplogroups for the New World had been identified (Wallace *et al.* 1985), and by 1990, Schurr and colleagues had defined the core RFLP mutations that define haplogroups A, B, C and D. In 1992, Wallace and Torroni labeled these haplogroups A, B, C and D, and 95–98% of all New World natives possessed one of those four types. At the time, the remaining 2–5% of haplotypes were thought to be due to European admixture. In the populations that were surveyed at that time, this assumption was mostly true. However, in 1994, Bailliet and colleagues identified some other putative haplotypes that were shared with the New World, and at least one other potential new haplogroup. These were confirmed by Merriwether and Ferrell (1996) and Easton and colleagues (1996). The new subtypes were labeled A1, A2, B1, C1, C2, D1, D2, X6 and X7 (Merriwether & Ferrell 1996). Later still, Brown and colleagues (1998) identified another founding lineage, confusingly also called X (hereafter Brown's X) that was unrelated to X6 and X7 haplotypes described by Easton and colleagues (1996). With the exception of Brown's X, all are found in Asia, and even all in one country (Mongolia, Merriwether *et al.* 1996, and Tibet, Torroni *et al.* 1994b), but most are absent in Europe, Africa, and Australia. Merriwether has used this to argue for a single wave of migration (Merriwether *et al.* 1994, 1995, 1996, 1999) as have others (Kolman *et al.* 1995; Bonatto & Salzano 1997; Forster *et al.* 1996). It must be noted the *Hae III* 16517 is a hypervariable site, turning on and off many times in evolutionary time, which decreases its utility as a phylogenetic marker. Nonetheless, over short time scales, this hypermutability can be a useful feature when placed upon the larger background of mtDNA genetic variation. It does mean that the sub-types, which only differ by this marker (*i.e.*, A1 vs. A2, X6 vs X7, etc.) may be different by a mutation which has happened within the New World, rather than prior to entry, despite the fact that it is found widely on both sides of the Bering Strait. Luckily, there are control region haplotype versions of A1 and A2, and D1 and D2 which are also shared between the New World and Asia (see Merriwether *et al.* 2000 for the specific sequence definitions), which also strongly supports the notion of more than one variant of at least A and D coming into the New World in the initial wave of migration.

Semantics also plays a role in the discussion, in the definitions of the terms haplotype, haplogroup, and founding lineage. A haplotype is a unique combination of RFLPs or mutations in a sequence. A haplotype may be represented by a single individual, or by many individuals that share an identical sequence. A haplogroup is a collection of closely related haplotypes which share at least one (and usually several) mutations in common that differentiate it from other such groups. A founding lineage is defined as one that initially entered the New World, from which the current Native American variation is now derived. Torroni and colleagues (1992) listed three criteria for a founding lineage which are useful to think about: 1) The lineage should be shared between the New World and the founding (parent) population, presumably in Asia or Siberia. 2) The haplotype should be nodal/central to the phylogeny of haplotypes in the New World. 3) The haplotype should be widespread in the New World. To this, I would add a fourth criterion that is helpful: 4) The haplotype should be found in ancient DNA that predates European contact.

Applying the above haplotypes, A, B, C, D, X6, X7 and Brown's X meet some or all of the criteria. All are found in ancient DNA that predates European contact (Stone & Stoneking 1998, 1999; Merriwether *et al.* 1994, 1997, etc.). Variants of A, B, C and D are clearly nodal/central to phylogenies, and shared between the New World and Asia/Siberia. The X6 and X7 lineages have been demonstrated to be derived from C and D haplogroups, and indeed share some C and D haplotypes identically when the D-loop sequences are compared from RFLP-defined X6, X7, C, and D individuals. Since X6 and X7 are found widely in Asia and Siberia, the question remains whether they migrated into the New World, or whether they represent revertant mutations that have lost the defining C and D RFLP mutations (both of which would require site gains, since C and D are defined by site losses at *HincII* 13259 and *AluI* 5176, respectively). Their wide dispersal in the New World, as demonstrated by Easton and colleagues (1996) and Merriwether and Ferrell (1996) would argue in favor of them entering as founding haplotypes. However, D-loop sequences from all these X6 and X7 individuals are required to evaluate the two scenarios for the origins and ages of X6 and X7. Hauswirth typed 40 of his 8000–9000 year old Florida Windover site samples for *AluI* 10397 and *DdeI* 10394 after learning of the X6 and X7 haplotypes from this author. Twenty were X6, 20 were X7, none were A, B, C, D, or Brown's X (see Hauswirth, personal communication cited in Merriwether *et al.* 1994). While it is certainly possible that X6 and X7 arose in the Americas, derived from C and/or D, the fact that they are found across a wide range of languages and geography argues that this must either be a very early event or a very frequent event. Given the frequency is very low, it is harder to imagine that it is a frequent event. The broad RFLP definition of X6 and X7 is very widely distributed throughout

Asia (using just the traditional A, B, C, D, markers plus *Alu* I 10397, *Dde* I 10394, and *Hae* III 16517). Sequencing of the New World X6 and X7 individuals is required to determine if they are shared with Asia. The few X6 and X7 sequences provided by Easton and colleagues (1996) were full of errors (a huge excess of transversions) and are of little value. Merriwether has been resequencing all of the samples from the Easton *et al.* (1996) paper, and some of the corrected sequences and haplotypes appear in Merriwether *et al.* (2000a). The rest will follow in a future paper.

Brown's X (Brown *et al.* 1998; Smith *et al.* 1999) is found widely in North America, but has not yet been confirmed in Central or South America. Smith and colleagues (1999) show that Brown's X is widespread across North America, including Athabaskan, Algonquian, Kiowa-Tanoan, Wakashan, Plateau-Penutian, Northern Hokan, and Siouan. It appears to be present in ancient DNA (Stone & Stoneking 1999). It has not been positively identified in Asia or Siberia, but does share a cluster of mutations with one old haplogroup in Europe. All the New World mtDNA lineages labeled Brown's X are at least 6 mutations different than those found in Asia, although they also share at least four mutations with those same Europeans. The implication is that the European Brown's X's and the New World Brown's X's have been separated for a very long time. The fact that it has yet to be completely identified in any populations between Europe and the New World has led to a number of (in my mind) highly questionable speculations about long range migrations across Asia, or worse yet, across the Atlantic Ocean (see Stanford and Bradley, this volume). The fly in the ointment may be a pair of partially intermediate haplotypes found in Korea (Lee *et al.* 1997, HVRbase ID # 05755; Burkhardt *et al.* 1999) and Mongolia (Kolman *et al.* 1996) that are identical to a pair of Nootka sequences from the New World (Ward *et al.* 1991, samples NCN3 and NCN4) that are closer to the New World variants than to the European variants of X. (See Merriwether *et al.* [2000] for a discussion of shared haplotypes between Asian and the New World). They are "partial" haplotypes because they were not sequenced or RFLP typed for all the defining markers, but possess 1–2 of the combination of defining mutations. Clearly further study of Asian and Siberian populations is required. It is also possible that in the 15–30,000 years since the migration(s) into the New World, the Brown's X lineages have gone extinct in Asia.

From Where?

There are a number of hypotheses regarding where the Native Americans came from. The most widely accepted, and least specific, is that they came from Asia. Turner (this volume) discusses this issue at length, concentrating on dental evidence. Thorough

screening of the peoples of Siberia and parts of Northern and Southeast Asia have yielded some possibilities for where the founders of the New World once lived. James Neel and coauthors (1994) suggested the Mongolia, Manchuria, Southern Siberia area as the source of the founding population for the New World. Merriwether and colleagues (1996) and Kolman and colleagues (1995) also suggested Mongolia as a source of the founders. Y-chromosomal studies (Lell *et al.* 1997; Karafet *et al.* 1999) have suggested the Lake Baikal region of Southern Siberia, as have some mtDNA studies (Schurr *et al.* 1999; Starikovskaya 1998). The Wallace lab has suggested (Torroni *et al.* 1992, 1993a, 1993b, 1994a, 1994b) that haplogroup B came over more recently than A, C, and D (after the "Amerind" migration into the Americas) because it has a shallower divergence time and has an apparently coastal distribution (west coast of the Americas and East Coast of Asia). They argue for a coastal migration originating somewhere in East Asia. This hypothesis has some support from Johanna Nichols linguistic analyses (1995; this volume) which also show a coastal distribution of some linguistic markers.

Problems

The problems with identifying source populations are many. There are different approaches taken to identify the source population, which can lead to different conclusions. A parsimony approach would argue for the minimum number of migration events that are consistent with the observed data. A frequency-based approach might argue for each lineage coming from the place where it is currently found at the highest frequency. Both approaches also rely on geographic proximity to the New World to resolve conflicts between competing potential source populations, with the ideal source population being located closest to the Bering Strait. These two approaches, by the way that they are formed, very often yield different results.

To put this into context, Merriwether and colleagues. (1994, 1995, 1996) and Merriwether and Ferrell (1996) took a parsimony approach to argue that since virtually all of the New World haplogroups are found in present day Mongolian populations (or populations originally from Mongolia, such as the Tibetans), they are the current best fit for being descended from the same parent population as the Native Americans. The present day Native Americans cannot be derived from the present day Mongolians. If the present day Mongolians are derived from the ancient Mongolians, then Mongolia is the best current source for New World's founders.

Michael Hammer's lab (Karafet *et al.* 1999) using Y chromosome data, Starikovskaya and colleagues (1998) and Schurr and colleagues (1996, 1999) using mtDNA and Y-data have applied the frequency-based approach, and argued for separate origins for a num-

ber of the Y and mtDNA haplogroups based on their differing frequencies in various Asian and Siberian populations. Even though some populations have all the requisite haplogroups (be it Y or mtDNA), they argue that separate waves of migration came out of the regions where the frequency is the highest.

Ancient DNA

One important component in evaluating the peopling of the Americas from a genetic perspective is ancient DNA. Ancient DNA provides the opportunity to test hypotheses derived from DNA from living populations. A number of studies have now been used to examine ancient human DNA variation in the Americas. O'Rourke and colleagues (1996) provide a good overview of these studies. Most of the ancient DNA studies in the New World involve pre-Columbian populations that lived within the last 3000 years (Stone & Stoneking 1996, 1998, 1999; Kaestle & Smith 2001; Matheny *et al.* 1992; Carlyle *et al.* 2000). Stone and Stoneking (1996) showed that an 8,000 year old female skeleton belonged to haplogroup B, and several others in the 8,000–10,000 year old age also belong to A, B, C, D, X6 or X7 (Merriwether unpublished data; Smith *et al.* 2000; Hauswirth *et al.* 1994). Much has been written about the feasibility of doing ancient DNA on the so-called Kennewick Man (Tuross & Kolman 2000; Merriwether in press), a 9,000 year old skeleton from Washington State that has been claimed for reburial. Much has been made of Kennewick Man's supposed European cranial features. Powell and Rose (1999) showed it had Asian/Pacific Islander craniometric affinities, as do many living Native Americans, and not European affinities. Three labs, mine included, tried to amplify DNA from a metacarpal and a rib from the Kennewick Man, but none were successful, or at least there were no conclusive results free of contamination from modern sources (as of the time of this publication).

It seems likely that lineages may have entered the New World and gone extinct anywhere up until European contact, and even more likely after contact. Ancient DNA may be the only way we will ever discover these lineages. Ancient DNA may allow us to differentiate between the many hypothetical peopling scenarios for the Americas, by telling us what haplogroups were present when and where at different times in the past.

Conclusions

We are still making new discoveries about the origins and affinities of Native Americans based on genetics data, and there is still much to learn. As marker densities get higher on the Y chromosome, this information is likely to play a more and more

important role in telling the story of the peopling of the New World. For now, some issues are still being debated, but a clear picture is emerging. These are that mtDNA haplotypes A, B, C and D all came over together. There were more than one variant of A, C, and D present in the group that founded the New World. X6 and X7 probably arose in Asia and came over with A, B, C and D, and X6 and X7 are derived from C and D. It is, however, also very possible that X6 and X7 arose from C and D in the New World sometime early after their arrivals.

Brown's X is only seen in North America, across many language groups. The only related sequences are a distant set of X-lineages in Europe, and a possible pair of partial-X-lineages in Korea and Mongolia. So until more data is in, Brown's X could either be part of the same wave of migration from Mongolia into the New World, or it could represent a separate migration. Since Mongolian (and Mongolian derived) populations already possess all the haplogroups for the New World (including the partial Brown's X, X6 and X7), it still has to be a leading candidate for the location of the source population for the Americas (using my parsimony criterion). The caveat would be that if population(s) closer to the point of entry had as many or more shared haplotypes, they probably would be considered better candidates for the source population region. So there is still strong support for a single wave of migration into the Americas, originating from Mongolia.

Abstract

In this paper, mitochondrial DNA evidence for the initial peopling of the New World is contrasted with different theories about the peopling of the Americas derived from other types of data. While the data have been interpreted in a number of ways, they are most consistent with a single wave of migration followed by differentiation. The exception to this may be the X haplogroup of Brown and colleagues (1998), which may or may not have been part of this initial migration.

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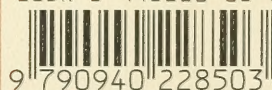
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